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STUDIES ON NUTRIENT ABSORPTION BY RICE PLANTS IN TAIWAN (PART 1)

Effect of Temperature on Nutrient Absorption by Rice Plants

by

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It is a general tendency of the yield of crops to increase in accordance with the increase of nutrient absorption. Since nutrient absorption is generally promoted under high temperature to a certain limit, yield should increase as the temperature gets higher. Takahashi (1952) reported that rice plants absorbed nutrients more in a high temperature condition than in a low temperature one, and considered that the nutrient absorption depends on the respiration of plant which in turn is influenced greatly by temperatures.

However, the grain yield of rice in the regions or in crop seasons under high temperatures is generally lower than under low temperatures. For instance, tropical countries generally give lower yield than temperate countries, and the yield of the second crop (July-October) in Taiwan is also less than that of the first crop (January-June) which is under lower temperatures.

It was suggested in this connection by Iso (1954) that in high temperature regions as in Taiwan, the growth of some Japonica rice varieties is promoted by intensive nutrient absorption, but flower initiation is advanced and the total yield might be reduced, because of a too short growing period. It has been also demonstrated that some Japonica varieties have relatively high fertilizer response under the high temperatures in Taiwan (Oka, 1956). However, those varieties are generally too early in maturity and their yield is low under the condition in Taiwan. Their earliness is due either to photoperiodic response or to their tendency to keenly respond to high temperatures so as to advance flower initiation. Owing to the rapid growth and prematurity, the total amount of nutrient absorbed might be reduced.

It is also commonly known in Japan that the straw/grain weight ratio of the yield of rice grown in warm climatic area is larger than that in cold climatic area (Togari, 1953). In the first and second crops of rice in Taiwan, the straw/grain weight ratio is noted as 110/100 and 120/100, respectively. Due to the rapid growth of rice under high temperatures, the nutrients absorbed may tend to be consumed for the formation of leaves and stems and for respiration, leaving little for the production of grains. Torii (1958) stated that the low yield in the second crop of rice in Taiwan, as compared with the first crop, is due to the reverse climatic conditions of the two crop

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seasons. Rice grows with rising temperatures in the first crop, while with declining temperatures in the second crop. This difference in temperature will strongly influence on the physiological activity of rice plants which in turn affect the response to fertilizer. He has shown some evidence for illustrating the cause and mechanism of high response of rice to potash under high temperatures.

However, the causes of low yield of rice in high temperature regions are still obscure in details. The authors are interested in the relation between climatic conditions and the growth of rice plants, and have taken up this study in order to throw some light on this problem from the view-point of nutrio-phisiology. Greenhouse experiments were conducted to clarify the actual status of nutrient absorption by rice plants under different temperatures, as reported in this paper.

METHOD AND MATERIAL OF EXPERIMENT

Pot experiments in glass-houses were conducted to investigate the effect of high and low temperatures on nutrient absorption and growth of rice plants.

1. Temperature treatment

Comparison was made between two glass-houses, one with closed windows and the other with opened windows.

2. Variety used

A Japonica rice variety, Taichung No. 65 was used. The soil for pot culture was taken from the experimental farm of this Institute. It is sandstone and shale alluvial soil, pH 5.5 and silt loam in texture.

3. Conditions of pot culture

Each of the pots was filled with 10 kgs of the above mentioned soil and was dressed with ammonium sulphate, calcium superphosphate, potassium sulphate at the rate of 1 gm of N, P_2O_5 and K_2O respectively, and 5 rice seedlings were planted inst. Five pot samples from each temperature treatment were taken five times at different growth stages as given in Table 1. 50 pots in total were thus observed.

Table 1. Sampling date (1st and 2nd crop, 1959)

	1st crop (days after planting)	2nd crop (days after planting)
Planting	March 26 (0 day)	Augugt 13 (0 day)
1st Sampling	April 28 (33 days)	September 8 (35 days)
2nd Sampling	May 15 (50 days)	October 1 (48 days)
3rd Sampling	June 1 (67 days)	October 21 (68 days)
4th Sampling	June 29 (95 days)	November 9 (87 days)
5th Sampling (harvest)	July 28 (124 days, Low temp. plot) August 8 (135 days, High temp. plot)	December 18 (126 days)

4. Recording of the growth of plant

Agronomic characters of rice plants, e. g. length of straw, number of culms etc. were investigated every week. Plant weight was also recorded at each sampling time, and the samples were divided into three parts after harvesting, i. e. stem, leaf and sheath, and grain providing for chemical assay.

5. Chemical analysis

Plant samples after air-drying were dried further in an electric oven at 85°C, and then were pulverized. Nitrogen content was determined by semi-micro Kjeldahl method. Micro-digestion of plant samples (Piper 1953) was adopted for phosphorus and potassium determinations. Molybdenum-blue method using hydrazin sulfate as reducing reagent was adopted for determination of phosphorus, and potassium was analyzed by flame photometric method.

RESULTS

1. Investigation of temperature

Room temperatures in the two glass-houses at 10 a. m. was recorded every day during the growing period. The former had always 2°~3°C higher than the latter as shown in Fig. 1. The average temperatures were as follows:

Table 2. Average room temparature at 10 a. m.

	1st crop (Mar. 26-Aug. 8)	2nd crop (Aug. 13-Dec. 18)
High temp. glass-house	30.9°C	29.8°C
Low temp. glass-house	27.9°C	27.0°C
Difference	3.0°C	2.8°C

2. Growth and yield of rice plants

Length of straw and tiller number measured at successive stages of growth are shown in Fig. 2. Plant weights at different stages are shown in Fig. 3.

Table 3. Measurements of agronomic characters at maturity

	1st crop		2nd crop	
	High temp.	Low temp.	High temp.	Low temp.
Length of straw (cm)	116.6	104.0	117.4	111.8
Number of tillers	26.6	26.2	26.4	26.8
Total yield (g/pot)	92.2	76.9	101.7	98.1
Grain (g/pot)	13.7	27.2	40.8	31.8
Straw (g/pot)	78.5	49.7	60.9	66.3
Grain/Straw	17/100	55/100	67/100	48/100

The high temperatures in the closed glass-house apparently promoted the elongation of straw, similarly in the 1st and 2nd crops. The date of heading in the high temperature plot was a little earlier than that in the low temperature plot. However, the number of tillers did not seem to be effected so much by the difference in temperature. The weights of plants in the high temperature plot, shown in Fig. 3, were larger, especially in the 1st crop, than that in the low temperature plot.

3. Inorganic nutrient absorption by rice plants

Table 4. Inorganic nutrient content of rice plants at successive growing stages (% on oven dry basis)

		High temp. plot				Low temp. plot		
		N%	P_2O_5%	K_2O%		N%	P_2O_5%	K_2O%
1st Crop	March 26 (planting)	1.14	0.868	1.56		1.14	0.868	1.56
	April 28	3.21	0.860	4.37		3.74	0.875	2.80
	May 15	4.21	0.808	4.56		4.41	0.890	2.35
	June 1	3.28	0.800	3.65		3.71	0.938	1.58
	June 29	1.79	0.657	1.94		1.55	0.701	0.91
	Aug. 8 (harvesting)	1.31	0.580	1.64	July 28	1.12	0.550	0.88
	Grain	1.32	0.615	0.64		1.32	0.611	0.62
	Stem	0.75	0.803	1.20		0.73	0.840	1.30
	Leaf	1.46	0.521	1.97		1.10	0.423	0.94
2nd Crop	Aug. 13 (planting)	2.86	0.958	3.65		2.86	0.958	3.65
	Sep. 8	3.64	0.985	4.94		3.74	0.943	5.04
	Oct. 1	3.50	0.938	44.2		3.18	0.825	3.65
	Oct. 21	2.20	0.782	3.50		2.28	0.792	2.98
	Nov. 9	1.45	0.660	2.52		1.52	0.644	2.09
	Dec. 18 (harvesting)	1.18	0.558	1.83		1.33	0.527	1.61
	Grain	1.40	0.702	0.65		1.58	0.698	0.67
	Stem	0.66	0.682	3.84		0.92	0.534	2.50
	Leaf	1.22	0.355	2.04		1.37	0.394	1.85

As shown in Table 4 and Fig. 4, the N, P_2O_5 and K_2O contents of the rice plants were increased gradually after transplanting. The plants showed the highest inorganic nutrient content at about 50 days after transplanting in the 1st crop and 25 days in the 2nd crop, then the nutrient contents made a slow dropping till harvesting time. It was found that the K_2O contents in the high temperature plot, especially in the 1st crop, were evidently higher than that in the low temperature plot. In the 1st crop, N and P_2O_5 contents of the plants before heading in the low temperature plot were a little higher than those in the high temperature plot, but in the latter stage, the order was reversed.

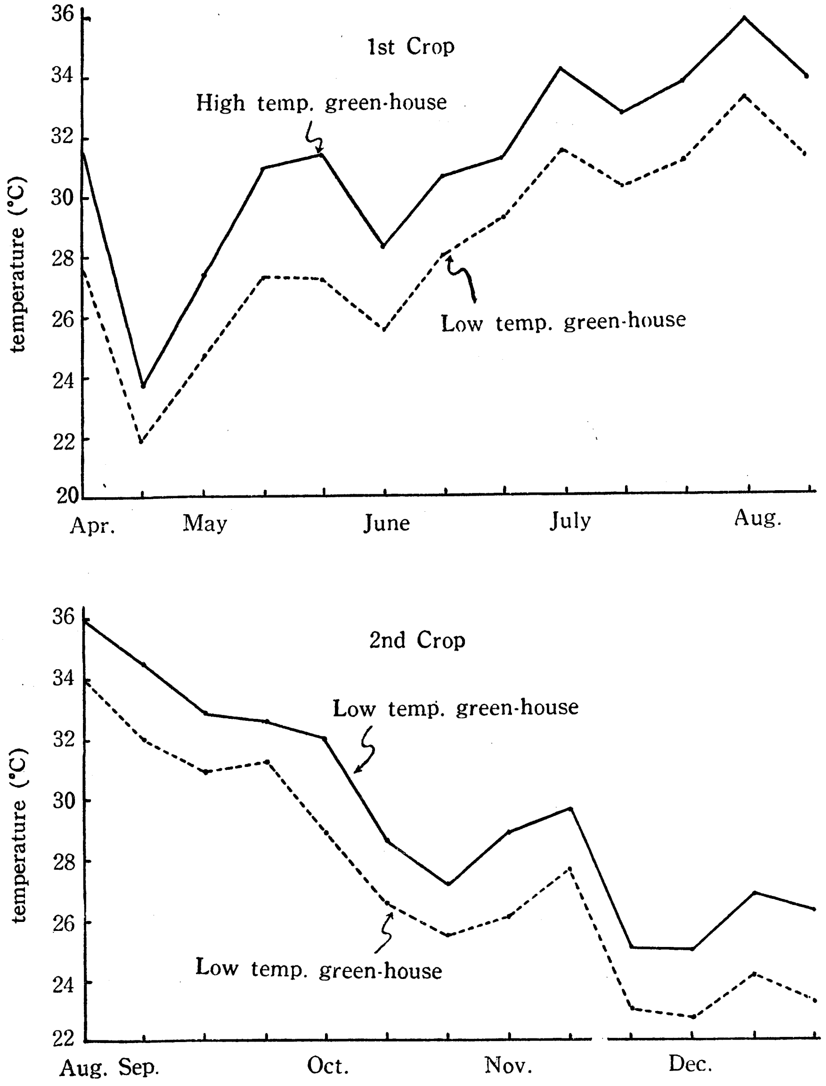

Fig 1. Change of temperatures in two glass-houses

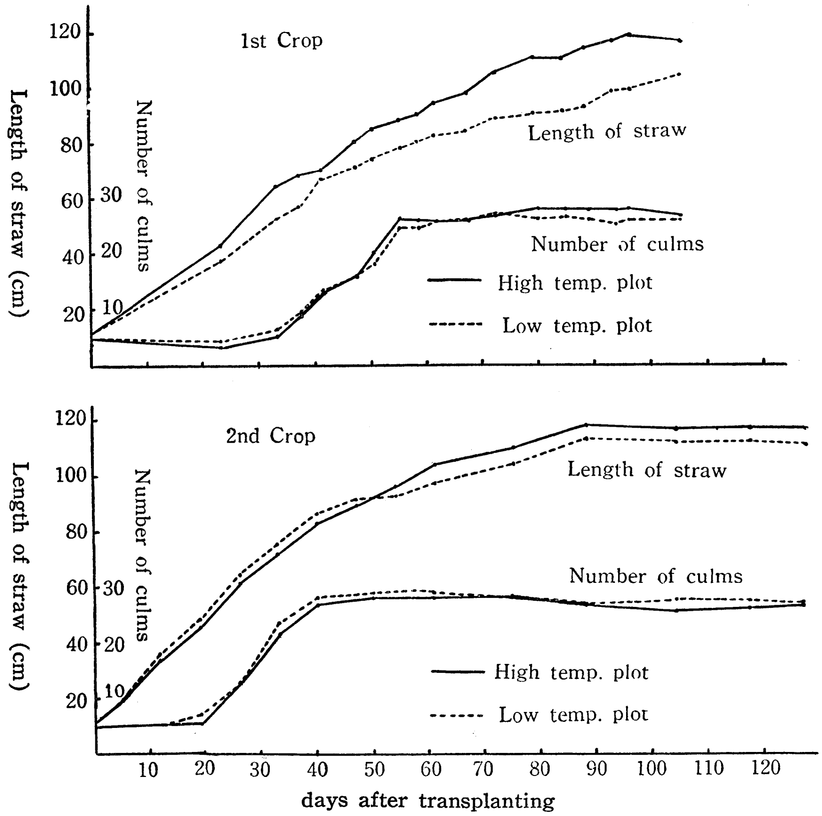

Fig 2. Growth status of rice plants at successive stage of growth

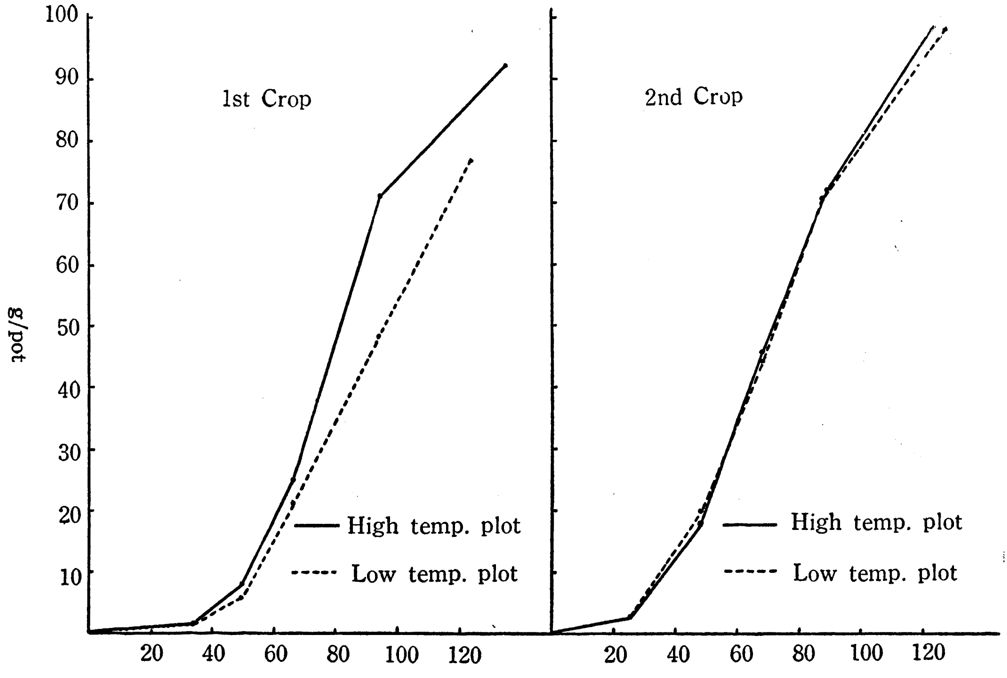

Fig 3. Weights of rice plants at successive stage of growth (air-dry weight per pot)

Table 5. Amounts of inorganic nutrients absorbed by rice plants at successive growth stages (mg/pot)

		High temp. plot				Low temp. plot		
		N	P_2O_5	K_2O		N	P_2O_5	K_2O
1st Crop	Mar. 26 (planting)	1.0	0.7	1.3		1.0	0.7	1.3
	Apr. 28	31.1	8.3	42.4		24.7	5.8	18.5
	May 15	275.7	52.9	298.7		231.5	46.7	123.4
	June 1	699.9	170.7	778.9		671.8	169.9	286.1
	June 29	1,036.8	380.5	1,123.6		730.8	307.9	399.7
	Aug. 8 (harvesting)	1,107.0	492.2	1,380.8	July 28	775.1	385.9	613.6
2nd Crop	Aug. 13 (planting)	1.6	0.5	2.1		1.6	0.5	2.1
	Sep. 8	65.9	17.8	93.8		93.5	23.6	126.0
	Oct. 1	568.4	152.3	717.2		562.5	145.9	645.3
	Oct. 21	870.8	309.5	1,386.9		888.7	308.7	1,160.0
	Nov. 9	910.6	414.5	1,582.6		936.9	397.0	1,287.0
	Dec. 18 (harvesting)	1,059.6	499.9	1,642.1		1,137.6	449.4	1,371.7

In general, the absorption of three elements by rice plants, especially of potassium, was promoted under high temperatures. In the 1st crop, the total amounts of potassium absorbed by a plant in the high temperature plot were twice as much as that in the low temperature plot, and moreover the amounts of potassium absorbed in the 2nd crop were larger than that in the 1st crop. This fact is of interest with regard to the favourable availability of potash fertilizers in the 2nd crop season of Taiwan in

(*Turn Page 10*)

Table 6. Distribution of inorganic nutrients in rice plants

			N		P_2O_5		K_2O	
			mg/pot	Index	mg/pot	Index	mg/pot	Index
1st Crop	High temp. plot	Grain	162.8	(15)	75.83	(15)	78.91	(6)
		Stem	111.4	(10)	119.24	(42)	178.20	(13)
		Leaf	832.8	(75)	297.18	(60)	1,123.69	(81)
		Total	1,107.0	(100)	492.25	(100)	1,380.80	(100)
	Low temp. plot	Grain	323.1	(42)	149.57	(39)	151.78	(25)
		Stem	81.6	(10)	93.91	(24)	145.34	(24)
		Leaf	370.4	(48)	142.42	(37)	316.50	(52)
		Total	775.1	(100)	385.90	(100)	613.62	(100)
2nd Crop	High temp. plot	Grain	503.02	(47)	252.23	(50)	232.83	(14)
		Stem	115.43	(11)	119.28	(24)	671.62	(41)
		Leaf	441.15	(42)	128.37	(26)	737.66	(45)
		Total	1,059.60	(100)	499.88	(100)	1,642.11	(100)
	Low temp. plot	Grain	446.03	(39)	197.04	(44)	189.71	(14)
		Stem	182.62	(16)	106.00	(23)	495.46	(36)
		Leaf	508.95	(45)	146.37	(33)	686.53	(50)
		Total	1,137.60	(100)	449.41	(100)	1,371.70	(100)

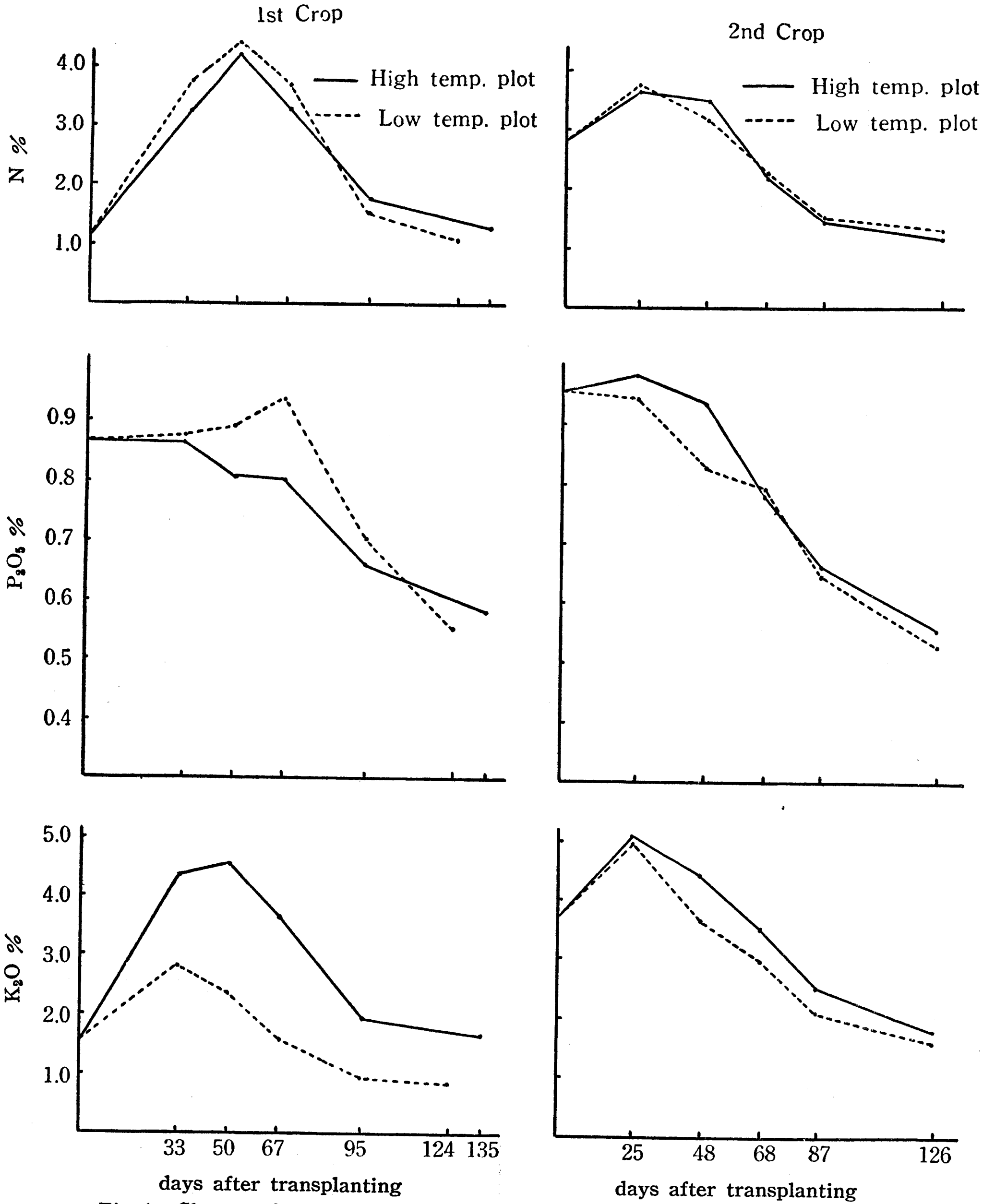

Fig 4. Change of nutrient contents in rice plants at successive growing stages

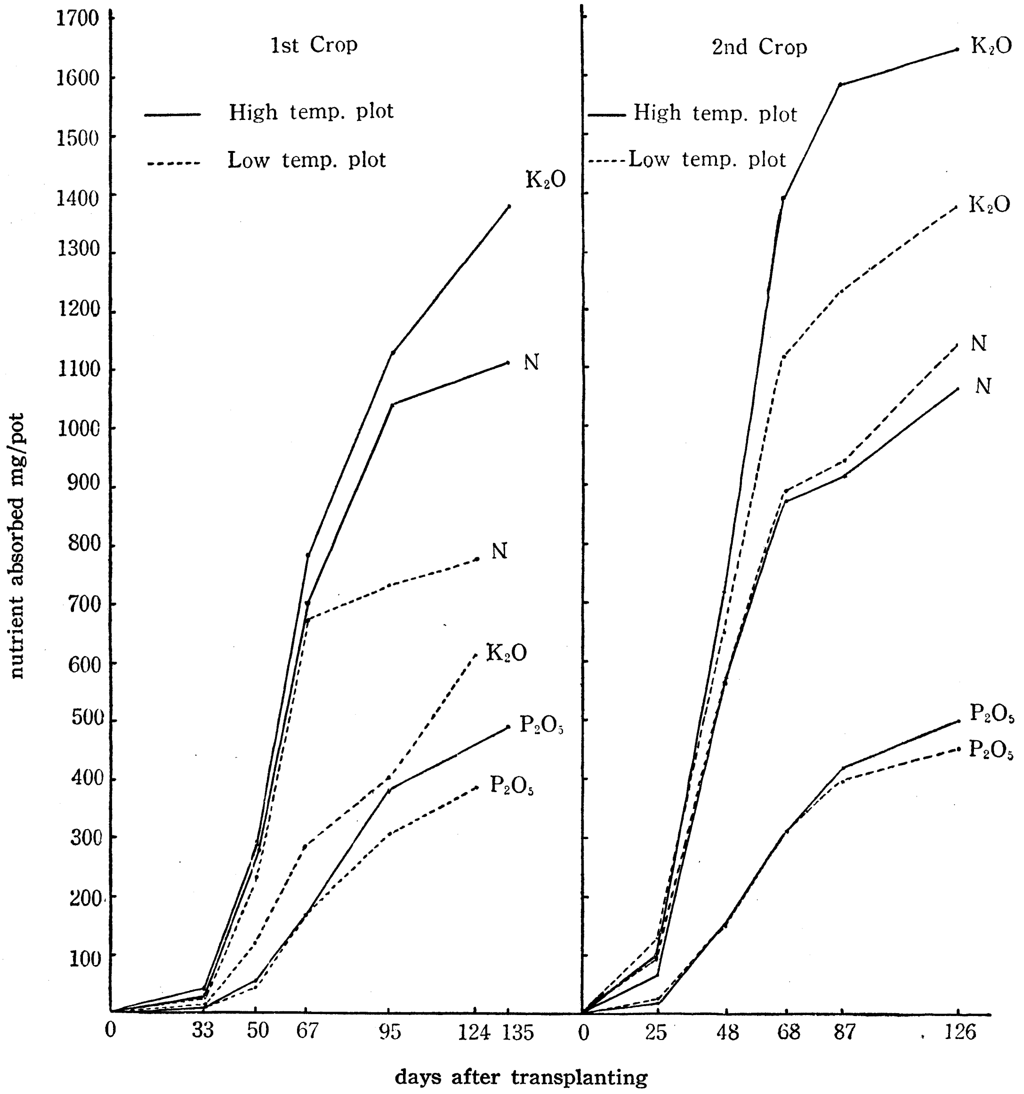

Fig 5. Amounts of nutrients absorbed by rice plants at successive growing stages

(*Continued Page 7*)

which the temperatures are high, a larger amount of potash fertilizer is needed than in the 1st crop season.

Under this glass-house condition, the rice plants absorbed the largest amount of potassium among three elements. Nitrogen absorption came to next and phosphorus the least. Taking the amounts of total K_2O absorbed to be 100, the amounts of N and P_2O_5 absorbed were calculated as 81 and 36 respectively.

OBSERVATION

1. To get different temperatures during rice cultivation, one glass-house with windows closed and the other with windows opened were set down as high and low temperature plot respectively, so far as our present equipment can provide.

They resulted in temperature difference of 2°～3°C between them, but temperatures in both glass-houses were still higher than that of natural field conditions. Under this expermiental condition, we found that the growth status, yield and nutrient absorption by rice plants were influenced greatly by the different temperatures.

2. The length of plants both in the 1st and 2nd crops under high tenperatures was apparently larger than that under low temperatures, but number of tillers did not show an apparent difference. High temperatures also advanced heading. In the high temperature plot, heading date was 7 days earlier than that in the low temperature plot in the 1st crop and 4 days earlier in the 2nd crop. Total dry matter weights of the plants in high temperature plot was higher than that in low temperautre plot, especially in the 1st crop.

However, for the grain yields, it was observed that greater complication might existed. As shown in table 3, grain/straw ratio in high and low temperature plots was 17/100, 55/100 in the 1st crop and 67/100, 48/100 in the 2nd crop respectively. In the 1st crop, high temperatures decreased the grain yield, but in the 2nd crop, this result was just reversed. The reason was considered as follows. The high temperature plot in the 1st crop had maximum temperatures over 40°C occasionally in daytime, which had affected the pollination of flowering time. As a matter of fact, a large number of sterile grain were produced and 60% of total number of grains were sterile. Consequently, total weights of grains were reduced in the high temperature plot.

It was also found that maturity of grain was prolonged for more than 10 days by the high temperatures and the plants continue to grow vigorously even at ripening stage at the higher temperature plot. While the plants at the low temperature plot became yellowing after heading as usual ripening process. The metabolism of rice plants during the ripening period by Murayama (1957) may confirm this fact. He stated that after heading, nutrients were translocated to ear and the existence of ear will cause yellowing of leaves and weakening of root activity. If the ear is cut

away, the plant may continue to grow up and increase the dry matter weights in other organs to compensate for the loss of ear.

In the case of the 2nd crop, the grain yields in the high temperature plot were better than those in the low temperature plot. In the later growth stage of the plants in this case, since the temperature was too low for the fruiting process of rice in November and December, the high temperature plot had rather adequate condition for grain yield.

3. As shown in Fig. 4, N, P_2O_5 and K_2O contents of the plants were at maximum at about 50 days after transplantion in the 1st crop and 25 days in the 2nd crop respectively, showing that the plants absorbed nutrients more rapidly at the early stage in the 2nd crop.

K_2O contents were always higher in the high temperature plot than that in the low temperature plot. Moreover, K_2O contents in the 2nd crop were also higher as compared with the 1st crop throughout the stages. This is of considerable theoretical interest in connection with the fact that potassium is readily absorbed by rice plants under high temperatures. However, in the low temperature plot in the 1st crop, the comparatively low concentration of K_2O in comparison with that of N throughout the growth stages can not be interpreted and require further investigation. For it is generally accepted that K_2O contents is higher than N contents in rice plants.

The temperature generally did not affect the N and P_2O_5 contents significantly, but it appeared that N and P_2O_5 contents in the low temperature plot were slightly higher than that in the high temperature plot before heading in the 1st crop.

4. Amounts of three elements absorbed by rice plants had a tendency in accordance with their concentrations in the plants. High temperatures certainly promoted rice plants to absorb potassium. According to Fujiwara (1956), potassium is regarded as a regulator for plant respiration. In the case of intense respiration, plants instinctively absorb more potassium to oppress respiration actibity. The high temperature treatment or comparatively high temperature in the 2nd crop, rice plants are certainly promoted the respiratory function which in turn might increase potassium absorption.

Average amounts and indices of N, P_2O_5, K_2O absorbed by rice plants per pot in this experiment were estimated as follows; N 1,019 mg (100), P_2O_5, 457 mg (45), K_2O 1,252 mg (123). Rice plants absorbed the largest amounts of potassium and the least of phosphorus.

5. According to the distribution of three elements in rice plants at harvesting as shown in Table 6, the greater part of nutrients was hold in straw rather than grain under high temperatures in the 1st crop. While in the 2nd crop, more nutrients were translocated to grain in the high temperature plot than in the low temperature plot. It resulted from proper conditions of temperature for grain yield as discussed in preceeding paragraph.

Judging from the above results, it may be stated that the study of nutrient absorption by rice plants would take an important role in the problem of the cause of low yield of rice in tropical countries. So, it is proposed to proceed the experiment along this line.

SUMMARY

The effect of high and low tempertures on the nutrient absorption by rice plants were studied by pot experiments in the two glass-houses. One glass-house with windows-clossed and the other with windows-opened are considered as the high and low temperature plots respectively. The former had temperatures 2°~3°C higher than the latter on the average during the growing period.

The growth status, yield and nutrient absorption by rice plants under these two temperature conditions were comparatively studied. The results were obtained as following.

Table 1. Growth and yield of rice plants at harvesting

	1st crop, 1949		2nd crop, 1959	
	High temp. plot	Low temp. plot	High temp. plot	Low temp. plot
Height of plant (cm)	116.6	104.0	117.4	111.8
Number of tillers	26.6	26.2	26.4	26.8
Total yield (g/pot)	92.2	76.9	101.75	98.1
Grain (g/pot)	13.7	27.2	40.80	31.8
Straw (g/pot)	78.5	49.7	60.95	66.3
Grain/Straw ratio	17/100	55/100	67/100	48/100

The high temperature apparently promoted the elongation of plants, similarly in the 1st and 2nd crops, but had little effect on number of tillers. The dry matter weights of the plants in the high temperature plot were always larger than those in the low temperature plot. In the 1st crop, high temperatures decreassed the grain yield, but in the 2nd crop, this result was just reversed. The details on yields were discussed in foregoing.

The N, P and K contents of the plants were increased gradually after transplanting. The plants reached the highest contents of N, P and K at about 50 days after transplanting in the 1st crop and 25 days in the 2nd crop, then the nutrient contents made a slow dropping till harvesting time. It was found K contents of the plants in the high temperature plot, especially in the 1st crop, were evidently higher than that in the low temperature plot.

In general, the absorption of three elements by rice plants, especially for potassium, was greatly promoted under high temperatures. In the 1st crop, the total amounts of potassium absorbed by the plants in the high temperature plot were twice as much as that in the low temperature plot. Moreover, potassium absorption was larger in

Table 2. Amounts of inorganic nutrients absorbed by rice plants (mg/pot)

	High temp. plot			Low temp. plot		
	N	P_2O_5	K_2O	N	P_2O_2	K_2O
1st crop	1,107	492.2	1,380.8	775.1	385.9	613.6
2nd crop	1,059.6	499.8	1,652.1	1,137.6	449.4	1,371.7

the 2nd crop as compared with that in the 1st crop. This fact is of interest with regard to the favourable availability of potasic fertilizers in the 2nd crop season in Taiwan in which the temperatures are high, a large amount of potassic feritizer is needed than in the 1st crop season.

Average amounts and indices of N, P_2O_5, K_2O absorbed by rice plants per pot in this experiment were estimated as follows; N 1,019 mg (100), P_2O_5 457 mg (45), K_2O 1,252 mg (123). Rice plants absorbed the largest amounts of potassium and the least of phosphorus.

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臺灣水稻之養分吸收之研究（第一報）

溫度對養分吸收之影響

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摘　要

本試驗目的在探討溫度對水稻養分吸收之影響。試驗於兩玻璃室內同時進行，其一係玻璃窗全部開啓，另一則全部關閉以爲比較上之高低溫區。其平均溫度差異如表 1.

表 1.　兩玻璃室平均溫度

	第一期作 1959	第二期作 1959
高　溫　區	30.9°C	29.8°C
低　溫　區	27.9°C	27.0°C
差　　　異	3.0°C	2.8°C

在此種溫度處理下擧行水稻盆栽，調査比較各階段之生育情形，養分吸收狀態和收量，結果如下。

（1） 水稻收穫時之生育狀態及穀藁收量如表 2.

表 2.　收穫調查結果

	第一期作 1959		第二期作 1959	
	高　溫　區	低　溫　區	高　溫　區	低　溫　區
株　高 (cm)	116.6	104.0	117.4	111.8
分蘖數	26.6	26.2	26.4	26.8
總收量 (g/盆)	92.2	76.9	101.75	98.10
穀 (g/盆)	13.7	27.2	40.80	31.80
藁 (g/盆)	78.5	49.7	60.95	66.30
穀/藁比	17/100	55/100	67/100	48/100

高溫處理無論在第一期或第二期作均促進水稻株高，惟對分蘖則影響很小。乾物總收量亦以高溫區大於低溫區。至於穀收量則第一期作之高溫處理顯然因對水稻之生殖生長具有惡劣影響，而致減低很多，但在第二期作高溫之効果却反而良好。其詳細如本文。

（2） 就水稻三要素含有率之推移狀態觀之，插秧後各要素之濃度均有增高，第一期作約於 50 天，第二期作約爲 25 天左右達到最高後開始逐漸減低，直至收穫期。三要素含有率之溫度處理間差異以鉀較爲明顯，卽高溫區之鉀素含有率顯然高於低溫區（尤其在第一期作）。

槪言之，溫度之提高顯然可以增加養分吸收量，惟此種傾向以鉀素爲最。如表 3. 第一期作高溫區之鉀素吸收量高於低溫區竟達兩倍以上。第二期之鉀素吸收量較之第一期作亦顯然提高。此

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種現象和臺灣第二期作之高溫下鉀肥肥效較第一期作明顯之事實對照，甚值進一步之探討。

表 3. 水稻無機養分吸收量 (mg/pot)

	高溫區			低溫區		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
第一期作	1,107.0	492.2	1,380.8	775.1	385.9	613.6
第二期作	1,059.6	499.8	1,642.1	1,137.6	449.4	1,371.7

本試驗水稻之三要素吸收量及其指數，平均每盆爲 N 1,019 mg (100), P_2O_5 457 mg (45) K_2O 1,252 mg (12.3) 可見水稻之養分吸收以鉀素最大磷素最小。

臺灣泥炭作爲肥料利用之硏究

（第一報） 臺灣泥炭之理化的組成

徐 水 泉 林 敬 德

一、諸 言

泥炭係繁茂於地上之各種植物殘骸經腐朽分解堆積而成，其有機質含量在乾物中佔50%以上，顏色多呈褐色乃至黑色，具膠體性質，組成份極爲複雜，其主要者爲腐植酸、Bitumina、纖維素、木素、蛋白質等。

土壤有機質爲土壤主要組成份之一，且亦是土壤微生物之主要養料，其來源係由所有地上棲息動植物，就中以植物之殘骸經腐朽分解殘留物爲主。土壤中之有機質含量之多寡與能否多量聚集堆積而形成泥炭，受種種因子之影響，其主要者爲土壤微生物種類、氣溫、雨量等爲較大。

在寒冷地帶或排水不良之沼澤地區、雜草、水草等極易繁殖茂盛，此種草類經腐朽後，因土壤微生物活動之期限短，活動力亦微弱，且氧氣缺乏，結果其分解作用進行頗爲緩慢，能殘留聚積多量有機質，如此逐年聚積增加，有機質堆積之厚度愈高而形成泥炭。

在熱帶及亞熱帶地區因氣溫高，植物生長繁殖極爲旺盛，可謂有機質來源甚豐富，但因其高溫，微生物之活動終年激烈，分解作用進行亦頗爲迅速，結果消耗多聚積反而較少，因此在臺灣除局部地區，環境特殊外，不宜聚積多量有機質形成如寒帶地方所稱之泥炭。但在臺灣有煤生產，其煤質較佳，經濟價值較高者，均爲地質年代第三紀中新統地層中之產物，至於地質年代較新之第三紀上新統及第四紀更新統地層中，往往夾有煤層，但其煤質可謂年代愈新煤炭化作用進行愈淺，發熱量低，煤質亦劣，此種煤炭據地質專家均可稱爲一種的泥炭。如屛東、恒春之薄煤層及中南部之嶺料山煤系，就中澎湖望島[1,2,3]及南投縣埔里[4]者均可稱謂屬於泥炭。此等泥炭卽是本研究所用者，爲避免與一般泥炭混淆，暫用臺灣泥炭代表之。臺灣泥炭之生成過程雖與煤炭類似，但因其生成年代較新，煤炭化程度輕微或幾無進行，植物組織間有未完全分解，尙保留類似有機質性狀者頗多。因泥炭之發熱量低而燃料的經濟價值不高，且未詳其適當用途，故被試堀之泥炭坑，仍毫未受業者注意，放任其自然，現坑口殆已塌沒或成廢坑，故泥炭之分佈，儲藏量等詳細狀況殆不明瞭。

泥炭之有機質含量多，且其性質與土壤有機質頗類似，具膠體性，吸着性等特性，直接可供應植物所需養分外，更能使土壤粒子團粒化，改善土壤物理性質，及吸着多量之氨，鈣等防止其流失等效能，在土壤肥料學上頗爲衆人之注意。有關泥炭之各種試驗研究甚多，成果亦不少。卽 Kotzmann 氏[5]曾以碳酸鈣中和泥炭之酸度，而後加入廐肥及氰氮化鈣而製造肥料。許新民氏等[6]以泥炭與化學肥料混合製成固體肥料，施行小麥及水稻盆栽試驗，結果可使小麥產量增加，但對水稻則無明顯之效果。Walton 氏[7]，Logvinova 氏[8]等曾用磷酸，磷酸二氫鉀處理泥炭後通氨氣，使其吸着製成氮肥，製品所含有機質及氮量均高，較硫酸錏爲優云。Davis 氏[9]在高氣壓中通氨氣使泥炭吸着製成含氮20%肥料。又以泥炭製造有機質肥料，現以商品化應市者有德國之"Huminal"及以色列之"Kabulan"，後者係採用 Halevy 氏法[10]由乾燥泥炭混合絲狀菌及細菌，堆積使其醱酵而製成，其有機物含量爲45.9%氮素1.8%，肥效頗高且甚安定云。又以泥炭粉末經化學處理後，接種荳科作物根瘤菌，並培養製成根瘤菌接種劑[11,12]，如 Bottomley 氏[13]之"Humogen"及美國 Nobbe, Hiltner 氏法製成之"Nitragin"等均有商品應市。

又有混入 Azotobacter 菌，或醱酵菌等製成細菌肥料，此外泥炭雖因煤炭化程度較淺，故發熱量低而作爲燃料的經濟價值不高，仍屬燃料之一無疑，因此 Rudeman 氏[14]，Clemens 氏[15]曾研究乾燥泥炭與添加劑混合，成型製成煉炭，獲得該專利者[16,17]，或製焦炭[18,19]等供爲燃料，工業的利用者，則有瓦斯製造[20,21]，泥炭膏 (Peat tar) [22,23]，色素[24,25]等用途甚廣。

就以上文獻觀之，泥炭之利用可謂甚廣，但關於此項研究在本省尙未多見，實爲可惜。適著者之一林敬德從事荳科作物根瘤菌接種試驗已略得結果，頗感製成粉狀接種劑以期實用方便。目前認爲適宜之粉狀接種劑基質材料雖有蔗渣，堆肥等粉末甚多，而且已有臺中農學院農化系教授吳敏慧之研究及發表[26]。但臺灣泥炭作爲肥料之利用亦值得注意的問題。故著者等由肥料觀點開始研究臺灣泥炭之性狀及利用，先將其各項理化的組成加以分析完畢，玆將其結果報告如下：

本研究在採樣時蒙澎湖縣政府李縣長玉林，臺大地質學系林教授朝棨，高雄區農林改良場謝場長鳴珂，及同場澎湖工作站鄭主任克溫等諸多協助，室內工作得農化系同仁之協助，特此申謝忱。

二、試 驗 材 料

採樣地點有二：

1. 南投縣埔里南方丘陵地山麓，水平坑，手掘後用竹籠拖出，現附近居民有利用爲低級燃料及煉炭製造之添加物。

2. 澎湖縣馬公南部海岸，玄武岩臺地之斷崖下部水平坑但坑口均已塌沒。

採樣及試料調製：

泥炭層與土層接觸部，摻雜泥土等雜物較多者除外，從泥炭層中採樣。

所採泥炭呈黑色，無光澤，濕潤，頗柔軟，有機物分解均良好且均質，經風乾磨碎後以供材料。

三、分 析 方 法

泥炭之組成甚爲複雜，其構成之成份種類頗多，故其化學成份之研究亦非容易，尤其有機腐植質爲甚。本試驗爲明瞭泥炭之一般的理化性質，以資將來肥料上利用研究之參考，故僅研討其主要成份，其分析方法及成份如下：

1. 水　份：照常法以 105°C 烘乾。
2. 比　重：用 50 c.c. 比重瓶測定，標準溫度 17.5°C。
3. 容水量：照常法測定，密狀態；重量%。
4. pH 值：用玻璃電極測定。
5. 灼熱減量及灰份：以烘乾試料，在電氣爐內以 650°C 燒灼至完全灰化，殘留物爲灰份，烘乾試料量減去灰份量即爲灼熱減量。
6. 全　氮：用 Gunning 氏變法測定。
7. 灰份中各成份：照常法施行定量硅酸、鐵、鋁、錳、鈣、鎂、磷、鉀、鈉等成份。
8. 全硫黃：用 Eschka 氏法[27]測定。
9. 揮發份：[28]秤取烘乾試料於鉑坩堝，在電氣爐內以 950°C 燃燒7分鐘後取出，冷後秤量，燃燒損失量爲揮發份。
10. 有機成份：[29][30]

(1) Bitumina

秤取試料10克置於紙筒中，經乾燥後置入 Soxhlet 氏抽浸器中，用醚抽浸至浸出液呈無色始止，吹乾，105°C 烘乾，秤量即得 Bitumina 量。紙筒中之殘渣在室溫乾燥，秤量後保存以供下

列成份分析。

（2） 水溶性有機物

Bitumina 分析殘渣秤取 4 克置於燒杯，加蒸溜水 100c.c. 煮沸半小時，濾過，用溫水洗滌，然後將渣移置原燒杯，再加蒸溜水 100c.c.，煮沸半小時，濾過，洗滌，如是反覆數次，至煮沸後溶液呈無色始止，將濾液收集並蒸發乾固，105°C 烘乾，秤量，再燒灼成灰份，烘乾所得重量減去灰份量即爲水溶性有機物量。殘渣經風乾後供粗纖維分析。

（3） 粗纖維

秤取殘渣 2 克置於錐形瓶，加1.25%稀硫酸 200c.c. 瓶口附加冷却器，煮沸使其緩緩沸騰半小時，濾過以沸水洗滌至中性，將殘渣以 200c.c. 1.25%氫氧化鈉溶液洗回於原錐形瓶，再煮沸使其緩緩沸騰半小時，用已知重量之 Gooch 坩堝濾過，洗滌，再用酒精洗滌，烘乾至恆量，然後燒灼成灰份，烘乾恆量減去灰份即得粗纖維重量。

（4） 蛋白質

用 Stutzer 氏法測定，秤取 Bitumina 殘渣 2 克置於燒杯，加蒸溜水 100c.c.，加熱至沸騰，然後加適量之氫氧化銅溶液使蛋白質沉澱，濾過，洗滌，照常法分解，測定其氮量，乘 6.25即得蛋白質量。

（5） 腐植酸、木素複合體

水溶性有機物之殘渣減去粗纖維及灰份，而殘餘者即爲腐植酸、木素複合體含量。

四、結果及討論

A. 泥炭之一般性狀

供試泥炭之性質及組成份分析結果如表一：

表一　泥炭之性質與組成份　　(風乾物百分比)

成份＼種類	埔里泥炭	澎湖泥炭	成份＼種類	埔里泥炭	澎湖泥炭
比重	1.667	2.382	Mn_3O_4	0.014	0.051
容水量	—	58.149	CaO	0.543	1.443
水份	31.798	14.866	MgO	0.067	0.233
灼熱減量	59.440	18.549	K_2O	0.183	0.139
灰份	8.755	66.585	Na_2O	0.074	0.654
全氮	1.183	0.187	P_2O_5	0.129	0.108
pH	4.05	7.20	SO_3	0.580	1.454
揮發份	36.639	17.979	Bitumina	1.870	1.433
硫黃	0.829	0.595	水溶性有機物	3.082	3.373
SiO_2	1.904	24.005	粗纖維	11.908	10.219
Sand	2.272	19.562	腐植酸・木素複合體	42.582	3.525
Fe_2O_3	2.568	3.805	蛋白質	7.996	0.468
Al_2O_3	0.623	15.457			

據表一所示，埔里泥炭水份31.798%，有機質 59.440%，灰分 8.755%，全氮 1.183%，揮發份 36.639%，pH 值4.05，澎湖泥炭則水份14.866%，有機質18.549%，灰份66.585%，全氮0.187%，揮發份17.979%，pH 值 7.20。茲就埔里與澎湖比較，兩者相差懸殊，其最明顯者則埔里泥炭之有機質含量高而灰份低，澎湖則反是有機質低而灰份高，埔里泥炭因有機質含量頗爲豐富，全氮，揮

發份隨之均高，又因有機質之吸水及儲水力甚强，故水份含量亦高，酸性較强者亦受有機質中之酸類影響所致。

澎湖泥炭之有機質含量雖比一般土壤之含量高，但僅爲18.549%反而灰分多達66.585%，因此影響其全氮等含量，pH 值亦近似中性。

就比重而言，埔里1.667，澎湖2.382，均與一般土壤之比重常數2.65較低，但前者相差較大後者則較接近，頗與其有機質含量符合。

容水量澎湖58.149%，埔里因風乾後難吸水，而無法測定，但似可認爲較高。

灰份中之無機成份，主要者均爲硅酸，氧化鐵，氧化鋁，且俱混摻土砂，尤澎湖爲甚，其他成份則較低。

有機成份，概約可認俱以腐植酸，木素及粗纖維爲其主成份，其他 Bitumina ，水溶性有機物，蛋白質含量則較低。

B. 泥炭之無機成份

茲就泥炭之無機組成份換算乾物百分比列於表二：

表二　泥炭之無機成份　　　　（乾物百分比）

種類 / 成份	埔里泥炭	澎湖泥炭	種類 / 成份	埔里泥炭	澎湖泥炭
灰份	12.837	78.212	CaO	0.796	1.695
SiO_2	2.792	28.197	MgO	0.098	0.274
Sand	3.331	22.978	K_2O	0.268	0.163
Fe_2O_3	3.765	4.468	Na_2O	0.109	0.768
Al_2O_3	0.913	18.156	P_2O_5	0.189	0.127
Mn_3O_4	0.021	0.060	SO_3	0.850	1.708

據表二所示，泥炭之無機成份含量，埔里12.837%，澎湖78.212%，而其砂含量埔里爲3.331%，澎湖22.978%，且硅酸，鐵鋁氧化物之含量均甚高。一般而言，泥炭之無機成份，皆由其構成植物之無機成份與被風雨冲刷而混摻之土壤無機物合併組成，而其含量因構成植物不同等影響，各地泥炭之無機成份含量高低頗爲參差。據 Waksman 氏[11]各種泥炭化學成份研究，羊齒泥炭之灰份1.8%爲最低，森林泥炭3.9%次之，谷澤泥炭 (Low moor) 13.2%，而湖泥炭 (Lake peat) 39.6%爲最高，則顯示地位愈低灰份含量愈高之趨向。據市村氏[30]謂日本北海道泥炭之灰份爲 8～12%，由此則可認本研究之泥炭，俱遭受土壤無機成份之影響，尤澎湖所受影響甚大。因之硅酸，氧化鐵，氧化鋁含量隨之均增高，且均佔其大部，而其他成份之含量則甚低，但可認爲有受影響，致使各成份高低互見。一般言之，鈣、硫酸均略高、鉀、磷等較低，錳均甚低。

就泥炭產地之土質言之，埔里由黃灰色砂岩化育而成，且受相當灰壤化作用[31]，而澎湖係由玄武岩風化而成，且有磚紅土化作用之趨向[32]，蓋玄武岩爲鹽基性岩石，其化成之土壤仍呈鹽基性，且富含鈉、鈣、鎂等成份，因此澎湖泥炭之鋁、鈣、鎂、鈉含量均示較高，pH 值亦受其影響而示較高。

總之，埔里、澎湖泥炭之無機成份，俱混摻土砂，而受土壤無機成份之影響較大，因之硅酸、砂、鐵鋁氧化物含量甚高，而其他之鉀、磷等成份均甚低。

C. 泥炭之有機成份

泥炭之有機成份換算乾物百分比列於表三：

表三　泥炭之有機成份　　(乾物百分比)

成份＼種類	埔里泥炭	澎湖泥炭	成份＼種類	埔里泥炭	澎湖泥炭
灼熱減量	87.153	21.788	粗纖維	17.460	12.003
全氮	1.735	0.220	腐植酸·木素複合體	62.435	4.141
Bitumina	2.742	1.683	蛋白質	11.724	0.550
水溶性有機物	4.519	3.962			

泥炭之有機成份係由其各種類之構成植物，受土壤微生物之作用，經腐朽分解後聚積而成，而因構成植物種類不同，植物中各種化合物，澱粉類、纖維等炭水化物、脂肪、臘質、木素、蛋白質等之分解難易速度頗爲參差，且參與分解工作之微生物種類差異等，諸多因子影響，所生成之有機成份，乃非一單純化合物，多係由種種複合體所組成且成份極爲複雜。

據 Waksman 氏[33]市村氏[30]研究，其主要者概約可分爲；Bitumina、水溶性有機物、粗纖維、腐植酸、木素複合體及蛋白質五成份，而 Bitumina 係由泥炭構成植物之臘、脂肪、樹脂等成份之腐朽分解生成物，而可溶於有機溶劑之黑褐色物質之總稱。水溶性有機物者，爲構成植物之有機酸類、炭水化物類、果膠等之水可溶性成份之總稱。腐植酸者係由構成植物之木素等之腐朽分解生成物質與蛋白質等之複合體組成，而可溶於鹼等之褐色具膠體物質之總稱。此等物質之化學組成份可謂極爲複雜，林氏等[34]曾用 Paper chromatography 由高位泥炭之腐植酸中分離 Arginine, Tyrosine 等14種 Amino 酸等，諸多學者從事分離並研究，但其化學組成尙待闡明之處頗多。

據表三所示，埔里、澎湖兩泥炭之有機質含量差異頗爲懸殊，因之其有機組成份亦頗參差，就埔里言之，腐植酸、木素複合體含量 62.435%爲最高，粗纖維 17.460%次之，蛋白質 11.724%略高，而水溶性有機物， Bitumina，全氮則較低。澎湖者粗纖維 12.003%最高，腐植酸、木素複合體 4.141%次之，蛋白質 0.550%示最低，水溶性有機物，Bitumina 俱較低，但與埔里較接近，全氮 0.220%亦頗低。茲就各組成份比較，差異最顯著者即埔里腐植酸、木素複合體含量高，而粗纖維低，澎湖則反是粗纖維高，腐植酸、木素複合體頗低。市村氏[30]研究，泥炭之有機質中腐植酸爲最多，即構成植物之腐朽分解愈進行，纖維，半纖維，水溶性有機物質，木素愈減少，反而腐植酸，Bitumina，蛋白質愈增加云。

茲檢討本試驗泥炭之各有機成份含量相關關係，則可認埔里泥炭之腐朽分解進行較深，但澎湖者，以粗纖維爲主成份，即換言之，構成植物之腐朽分解似較淺，且其有機物含量亦甚低等，頗難稱爲泥炭。

茲爲資更明瞭本試驗所用泥炭之性狀，就美國等各種泥炭之化學成份列於表四，並比較檢討如次。

表四　各種泥炭之化學成份　　(乾物%) 據 Waksman[11]

泥炭成份＼種別	谷澤泥炭 美國	湖泥炭 美國	森林泥炭 美國	羊齒泥炭 德國	羊齒泥炭 美國	羊齒泥炭* 日本	埔里泥炭	澎湖泥炭
Bitumina (Ether solu.)	0.7	0.4	3.2	3.1	2.5	5.16	2.74	1.68
水溶性有機物	3.1	0.7	…	…	…	17.23	4.52	3.96
半纖維	10.3	4.2	5.4	16.9	20.9	13.09	17.46	12.00
纖維	0	0	2.7	19.4	16.2	8.00		
腐植酸·木素複合體	38.4	35.2	60.7	34.0	25.4	44.68	62.44	4.14
蛋白質	22.5	15.1	14.3	.5.2	5.7	9.79	11.72	0.55

灰　　份	13.2	39.6	3.9	1.7	1.8	11.84	12.84	78.21
pH	5.9	7.3	4.7	4.1	4.0	3.03	4.05	7.20

* 市村氏(30)

如表四所示，泥炭之各種成份，因生成過程及地域不同而含量高低較參差，但均具明顯傾向，則腐植酸、木素複合體含量差異雖較大，其所佔百分比均高，而成爲主成份，半纖維，纖維含量者，除德美兩羊齒泥炭略高外，均比主成份頗低，蛋白質5.2～22.5%亦較高，且示與纖維含量成反比例，至於 Bitumina 及水溶性物質，除日本羊齒泥炭略高外均較低，灰份爲湖泥炭最高，谷澤，日本羊齒泥炭少有摻雜土砂而較高外均頗低，pH 值除湖泥炭受摻雜土砂影響而呈中性外，乃均屬強酸性。

埔里泥炭之比較，主成份腐植酸、木素複合體略高，蛋白質比羊齒泥炭高，粗纖維反而較低，而 Bitumina，水溶性物質，灰份，pH 值均低。澎湖者腐植酸、木素複合體及蛋白質均甚低，粗纖維量雖中等却反是成爲主成份，灰份即超過湖泥炭頗多等，差異頗大。

總之埔里泥炭除粗纖維，灰份含量較高外，各種成份均與森林泥炭較接近，且尚稱符合，澎湖者則頗差，因之可謂難稱爲泥炭，而稱爲"有機質土壤"，似較適當。

五、摘　　要

泥炭之生成受氣候因子之影響，多形成於寒冷地帶，而熱帶亞熱帶地區則頗爲鮮見，但在臺灣地質上屬於第三紀上新統及第四紀更新統地層中，有炭化程度輕微尙保留頗多量類似有機質性狀而幾無燃料的經濟價值者可稱爲泥炭。

本研究以肥料立場檢討該泥炭之性質，及利用爲目的而舉行者，玆就南投縣埔里及澎湖縣馬公兩處泥炭之理化的性質分析結果摘要如下：

1. 埔里、澎湖俱混摻土砂，埔里較少澎湖却甚多，因之比重，有機質、全氮、揮發份等組成份參差頗爲懸殊。

2. 無機成份，俱受土壤無機物之影響，均以硅酸、砂、鐵鋁氧化物佔其大部，而鈣、磷、鉀等均甚低。

3. 有機成份，埔里含量甚高，而以腐植酸、木素複合體爲主成份，粗纖維，蛋白質略高，Bitumina，水溶性有機物較低，澎湖則含量低，而以粗纖維爲主成份，其他成份則低。

4. 埔里產者：比重1.667，水份31.798%，有機質59.440%，灰份8.755%，全氮1.183%，pH值4.05，揮發份36.639%。

5. 澎湖產者：比重 2.382，水份 14.866%，有機質 18.549%，灰份 66.585%，全氮0.187%，pH值7.20，揮發份17.979%。

6. 埔里產之諸成份與美國等泥炭比較，則尙稱符合，澎湖者則頗差，似稱爲"有機質土壤"較妥當。

7. 據上述結果著者認爲在肥料利用上埔里產泥炭爲較適合之原料。

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STUDIES ON THE UTILIZATION OF TAIWAN PEAT AS FERTILIZER

First report: physico-chemical composition of Taiwan peat

by

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SUMMARY

Generally speaking, peat have never seen in the sub-tropical or tropical reagions. But according to the geological survey reports, in Taiwan, there are a few deposit of so called peats which existed in the earth layer from the Pliocene period of Pretertiary or the Pleistocene period of Quaternary.

Peat is less in economic value as a fuel but it may be used as fertilizer. So, in

order to realize the utilization of Taiwan peat as fertilizer, the preseut study was started. This is the preliminary report about the physico-chemical composition of the two kinds of peat were taken from Puli district and Pescadore island.

The results are summarized as follows:

1. It is very different in specific gravity, content of organic matter, total nitrogen, volatile matter due to the content of sand between the two groups of peat collect from Puli and Pescardore island.

2. In the inorganic compositions, the sand, silica and sesquioxides occupy a great part in percentage of composition, the low content in calcium, phosphorus and potassium.

3. The total amount of organic matter is more higher in Puli district than in Pescadore island. In the organic composition of peat in Puli, the humic acid-lignin complex is the main component, the crude fiber and protain next the low content in the bitumina and water soluble organic matter. For the peat in Pescadore island, the crude fiber is the main component and the others are low in content.

4. The physico-chemical compositions of peat in Puli and in Pescadore island are shown as Table I.

Table I.

	Puli	Pescadore island
Specifiic gravity	1.667	2.382
Moisture (%)	31.798	14.866
Organic matter	59.440	18.549
Total nitrogen	1.184	0.187
Volatile matter	36.639	17.979
Ash	8.755	66.585
pH	4.05	7.20

5. From the chemical properties of peat in Pescadore island, it is possible to recognize that it belongs to a soil of high content of organic matter.

6. According to the Table I the peat distributed in Puli district is more suitable for fertilizer use than the peat collected from pescadore island.

球莖甘藍品種比較試驗

李伯年　諶靜吾　林昭雄

民國四十五年秋季全省蔬菜改進試驗工作，從福建金門引進一個早生球莖甘藍品種，在省內十一個試驗場所試作結果，均認爲早熟豐產，品型優美；翌年擴大區域試作及示範栽培，全省120個栽培農戶，亦一致稱好。至四十七年秋季農業試驗所，曾將金門早生球莖與美國白蕪球莖（White Vienna)及日本金澤球莖甘藍三個品種，作比較試驗。金門早生球莖甘藍所得結果，可歸納下列數點：(1)外葉稀少，(2) 食用部份收穫率高(球重佔全重達72.78%)，(3)球型扁圓，外觀優美，(4)商品價值大，(5)早熟豐產。詳見如下各表：

表一　金門早生球莖與美國白蕪球莖及日本金澤球莖甘藍品種形質之比較

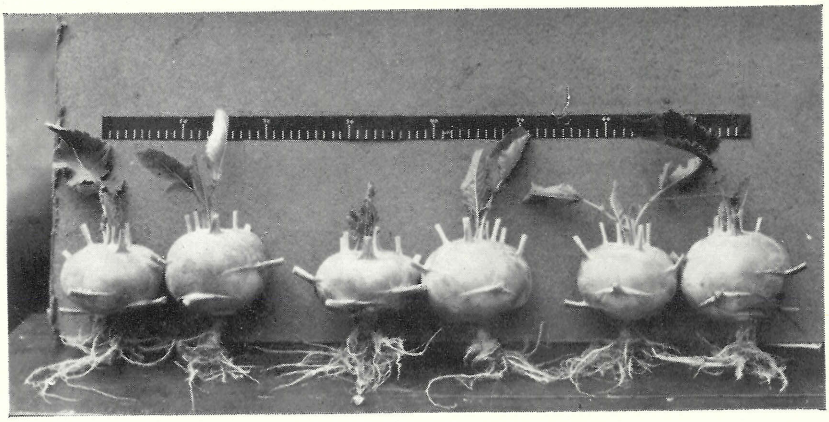
Table 1. Comparison of characters of kohlrabi varieties.

品　種 Varieties	根長 Length of Roots (cm)	葉長 Length of Leaves (cm)	葉數 Number of Leaves (枚)	葉重 Weight of Leaves (g)	球重 Weight of Bulbs (g)	根重 Weight of Roots (g)	全重 Total weght of Plants (g)	球重佔全重之% Percentage of Bülb Weight	球徑 Diameter of Bulbs (cm)	球高 Height of Bulbs (cm)
美國白蕪球莖 White Vienna (U. S. A.)	16.79	43.11	22.90	272.80	698.60	29.70	1,001.10	69.78	10.31	11.37
日本金澤球莖 Kanazawa (Japan)	21.74	55.11	24.40	606.80	660.70	65.40	1,332.90	49.56	10.15	11.13
金門早生球莖 Kinmen Early (China)	18.01	50.41	17.20	276.60	799.10	28.20	1,103.90	72.78	12.03	9.29

說明：(1)　全重係葉重、球重、根重三部之總和。
　　　(2)　調查株數各品種均爲100株之平均數。

圖一　金門早生球莖甘藍品型圖

Fig. 1 The characteristic of Kinmen Early Kohlrabi



表二 金門早生球莖甘藍全省各地示範栽培成績一覽

Table 2. List of the province-wide trial planting and demonstration of Kinmen Early

負責示範栽培單位 Supervisory Agencies	示範地點 Place of Demonstration	示範農戶 No. of Farm (戶)	10公畝平均產量 Aver. Yield per 10 Are (kg)	示範農戶評語結論摘要 Reputation of Demonstration
臺灣省農業試驗所 T. A. R. I.	新店、木柵、景美等四鄉鎮	12	2,518.80	早熟品質佳外葉少、球型扁平商品價值高農民非常歡迎
士林園藝試驗分所 Shihlin Station	士林、淡水、社子等四鄉鎮	12	2,571.20	球莖大、外葉少、收量豐
鳳山園藝試驗分所 Fengshan Station	鳳仁、仁武、楠梓、路竹等四鄉鎮	12	968.00	肉質優良、早熟
臺北區農業改良場 Taipei DAIS.	三重、北投、土城等四鄉鎮	12	1,540.00	早熟豐產、適合農民栽培興趣
新竹區農業改良場 Hsinchu DAIS	苑裡、竹南、湖口等四鄉鎮	12	3,880.00	球型美觀、早熟豐產、品質極佳
臺中區農業改良場 Taichung DAIS	新社、豐原、烏日等四鄉鎮	12	1,666.86	球型美觀、農民極表觀迎
臺南區農業改良場 Tainan DAIS	麻豆、嘉義、虎尾、朴子等四鄉鎮	12	886.60	極早熟發育整齊、適于早期栽培
高雄區農業改良場 Kaohsiung DAIS	岑雅、新園、內埔等四鄉鎮	12	4,424.20	早熟豐產、耐熱抗病性均强、農民極爲歡迎
臺東區農業改良場 Taitung DAIS	臺東、關山、卑南等四鄉鎮	12	1,770.60	極早生豐產農民均極歡迎
花蓮區農業改良場 Hwalien DAIS	吉安、玉里、鳳林等四鄉鎮	12	2,086.00	品質佳、早熟、抗病力强
各場所合計 Total	40 鄉鎮	120	22,312.20	
各場所平均 Average	4 鄉鎮	12	2,231.22	

民國四十八年秋季，農業試驗所爲證實金門早生球莖甘藍之優點更加瞭解起見，又以五個品種作比較試驗，所得結果，外葉稀少，收穫率高，球型扁平美觀，早熟豐產，金門早生球莖甘藍仍佔第一位，詳見下述：

1. 各品種葉型之比較——金門早生球莖甘藍葉柄細軟，葉身狹長而薄，且葉數又少，因此葉重較輕，佔全重之百分比僅 16.85 %。白蕪球莖甘藍，葉柄雖細，葉身狹而不長，但葉數特多，故葉重增加，佔全球之百分比達 22.52 %。美國早生球莖甘藍，葉身濶大，葉柄粗硬，因而葉重增加，佔全重之百分比雖較白蕪甘藍略低，亦在 22.01 %。北京球莖及金澤球莖甘藍二品種，葉數雖不多，因葉柄粗長而硬，且葉身長濶而大，葉肉厚，葉脈粗，故葉重增大，前者葉重佔全重之百分比達46%，幾佔一半，後者亦在 43.88%，詳見下表：

表三 各品種葉型之比較

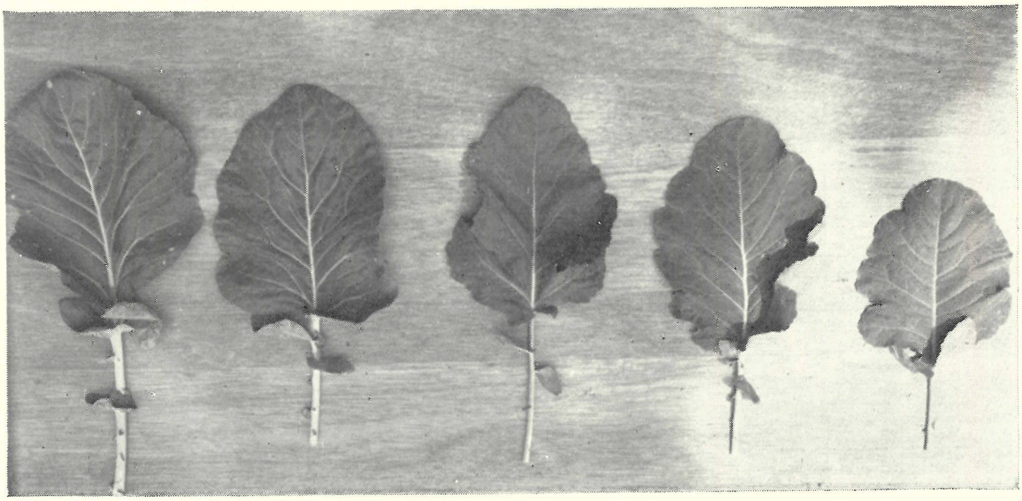
Table 3. Comparison of leaves of kohlrabi varieties

品種 Varieties	全重 Total Weight of Plants (g)	葉數 No. of Leaves (枚)	葉重 Weight of Leaves (g)	葉長 Length of Leaves (cm)	葉濶 Width of Leaves (cm)	葉厚 Thickness of Leaves (cm)	葉柄粗 Thickness of Leafstalks (cm)	葉重佔全重之% Percentage of Leaf weight	位次 Order
金門早生球莖 Kinmen Early	1,129.7	18.10	190.40	47.66	16.63	0.046	0.605	16.85	1
美國早生球莖 American Early	1,332.1	22.30	293.20	42.16	19.40	0.032	0.745	22.01	2
白蕪早生球莖 White Vienna	1,076.4	27.80	242.50	33.77	14.88	0.052	0.516	22.52	3
北京晚生球莖 Peking Late	1,200.2	22.50	552.10	48.45	22.43	0.065	0.924	46.00	5
金澤晚生球莖 Kanazawa Late	1,320.6	21.10	579.50	51.73	20.93	0.058	0.889	43.88	4

說明：(1) 全重係葉重、球重、根重三部之總和。
(2) 調查株數各品種均爲50株之平均數。

圖二　各品種葉型之比較圖

Fig 2.　The characteristic of leaves of kohlrabi varieties



金澤晚生球莖 Kanazawa Late　　北京晚生球莖 Peking Late　　金門早生球莖 Kinmen Early　　美國早生球莖 American Early　　白蕪早生球莖 White Vienna

2. 各品種球型之比較——金門早生球莖甘藍，球型扁平不高，外皮光滑、美觀、根雖細長而不粗大，因而球莖重量佔全重量之百分比達 80.80 %，其食用部份收穫率之高爲各品種之冠。美國早生及白蕪球莖甘藍，球型特高，呈圓椎形狀，且外皮有起伏狀，不甚美觀，球莖重量佔全重量之百分比，前者爲7.30%，後者爲75.09%，略遜于金門早生球莖甘藍；至于北京球莖及金澤球莖甘藍，球高與球徑均略相等，呈圓球狀，因葉柄粗硬，所留之葉柄痕跡亦特粗，並葉柄基部，常生附屬葉片，皮色青綠，外皮不甚雅觀，球莖重量，前者佔全重之百分比僅 50.09%，後者爲 52.37%，故食用部份之利用率極低，詳見下表：

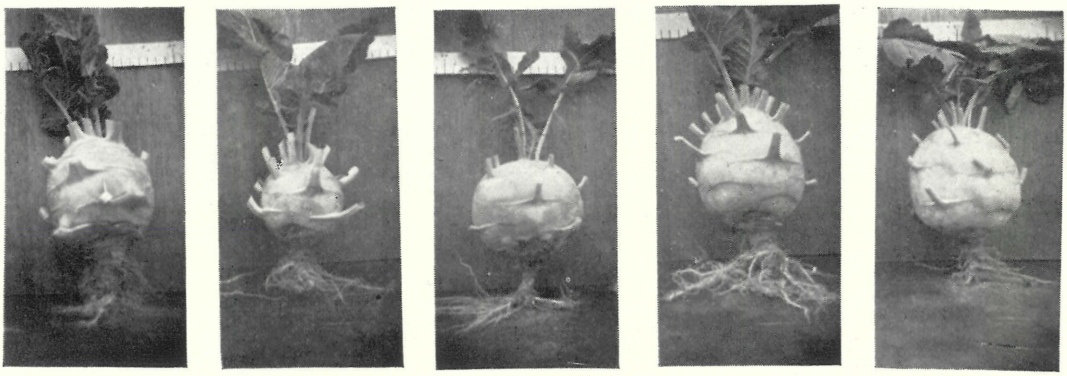
表四　各品種球型之比較

Table 4.　Comparison of bulbs of kohlrabi varieties.

品　種 Varieties	全　重 Total Weight of Plants (g)	根　重 Weight of Roots (g)	根　長 Length of Roots (cm)	球莖重 Weight of Bulbs (g)	球莖高 Height of Bulbs (cm)	球莖直徑 Diameter of Bulbs (cm)	株　高 Height of plants (cm)	球莖重佔全重之% Percentage of Bulbs	位　次 Order
金門早生球莖 Kinmen Early	1,129.7	26.5	16.14	912.8	9.553	12.023	55.692	80.80	1
美國早生球莖 Amerien Early	1,332.1	27.5	13.39	1,017.4	13.068	11.624	49.240	76.30	2
白蕪早生球莖 White Vienna	1,076.4	25.6	13.07	808.3	13.728	10.431	43.900	75.09	3
北京晚生球莖 Peking Late	1,200.2	45.0	14.08	603.1	10.584	9.812	53.960	50.09	5
金澤晚生球莖 Kanazawa Late	1,320.6	49.5	14.83	691.6	11.344	10.109	58.300	52.37	4

圖三　各品種球型之比較圖

Fig. 3 The characteristic of bulbs of kohlrabi varieties



金澤晚生球莖 Kanazawa Late　　北京晚生球莖 Peking Late　　金門早生球莖 Kinmen Early　　美國早生球莖 American Early　　白燕早生球莖 White Vienna

3. 各品種產量之比較——五個品種于四十八年九月十五日播種育苗，十月十六日移植。各品種栽培面積爲0.1公畝，各栽四十株，至十二月二十日收穫。比較其產量，就全重量而言（包括葉、球莖、根三部份）以美國早生球莖收量最高，金澤爲球莖第二，北京球莖第三，金門早生球莖第四，白燕球莖爲第五。除去葉和根，單以球莖之重量比較其產量，則以金門早生球莖佔第一，美國早生球莖爲第二，白燕球莖第三，金澤球莖第四，北京球莖爲第五。詳見下表：

表五　各品種產量之比較

Table 5. Comparison of yield of kohlrabi varieties

品種 Varieties	定植距離 Plant spacing (cm)	0.1公畝栽植株數 No. of Plants per 0.1 are	0.1公畝收量全重 Total Yield Per 0.1 are (kg)	0.1公畝收量球重 Yield of Bulbs per 0.1 are (kg)	球重折10公畝收量 Yield of Bulbs per 10 are (kg)	球重收量順位 Order of Bulb Yield
金門早生球莖 Kinmen Early	50×40	40	45.188	32.512	3,251.20	1
美國早生球莖 American Early	50×40	40	53.284	30.696	3,069.60	2
白燕早生球莖 White Vienna	50×40	40	43.056	27.332	2,733.20	3
北京晚生球莖 Peking Late	50×40	40	48.008	24.124	2,412.40	5
金澤晚生球莖 Kanazawa Late	50×40	40	52.824	27.664	2,766.40	4

根據上述試驗結果，金門早生球莖甘藍之優點可歸納四點如下：

（1） 當第一次三個品種比較試驗以金門早生球莖甘藍優點爲最多，經第二次五個品種比較試驗，仍以金門早生球莖甘藍列第一位，由此可知確爲一個早熟優良品種，無可異疑。

（2） 蔬菜栽培改良之主要目的，旨在求得利用部份收穫率之增高，球莖甘藍之主要收穫部份是在球莖，而不是葉和根。金門早生球莖甘藍外葉少葉柄細軟，主側根不多，爲球莖收穫率增多之

主要條件。故兩次試驗結果，恒在各品種之上。

（3） 因金門早生球莖甘藍外葉少且葉柄細軟，適于密植而增收益，又因其早熟豐產，爲臺灣冬季大量水田裏作之優良品種，故一般栽培者均極歡迎。

（4） 雖屬早熟品種，在臺灣北部延遲到十一月下旬播種，仍能與晚熟品種媲美於田間。

COMPARATIVE EXPERIMENT ON VARIETIES OF KOHLRABI

by

P. N. Lee, C. W. Shen & C. H. Lin

SUMMARY

According to the above results based on the observations of experiments, the characteristic of Kinmen Early is attributed to the following four points:

1. Through twice comparative experiments, (the first experiment contains three varieties—Kinmen Early, White Vienna and Kanazawa Late; the second contains five varieties—Kinmen Early, American Early, White Vienna, Peking Late and Kanazawa Late). Kinmen Early variety is acknowledged and certified as the best variety of kohlrabis, because of its early maturity and high yield of edible bulbs.

2. The main purpose of improving vegetables is to increase the yield of the available parts. The principal edible part of kohrabi is bulb not leaves or root. The bulb should have clear, white, and tender flesh, and crisp texture. Kinmen Early has many superior characters such as oval bulbs, small leaves, fine leafstalks, high yield of edible bulbs and good commercial value.

3. Owing to the small leaves and flexible leafstalks, Kinmen Early is suitable to be planted closely, and can, therefore, increase the yield and profit. It can serve as the superlative variety of the intermediate crop in paddy fields in winter season. Owing to the early maturity and high yield, it is welcome by producers in Taiwan.

4. Although Kinmen Early is an early mature variety, seeding can be postponed till the end of November, and can still stand in competition with the late varieties in the fields.

洋葱品種比較試驗報告

郁宗雄　王進生　李伯年

一、前　　言

臺灣洋葱品種之引進試植，最早開始於日據初期1912年，臺北縣淡水鎮國民小學有一位日籍教師，從日本引進種子試植於校園內，連續工作二年，認爲臺灣氣候可以栽植洋葱。至1918年臺灣省農業試驗所，亦引進洋葱品種，在臺北試植，感於冬春兩季多雨，未獲優良成績；經移至南部嘉義繼續試驗，結果幼苗時期多病害，成績亦差，生產成本不如從日本輸入葱球，反較合算，於是各試驗機關研究工作停頓，將近三十年。

臺灣光復後，1950年臺北區農業改良場又開始洋葱品種引進工作之研究，發現早熟品種，在臺灣北部氣候，水稻田裏作，可獲得葱球；惟葱球開始膨大時期，春雨連錦不停，所結葱球，含水份過多，易起腐爛，不耐久藏爲一缺點；經數年研究，欲推廣於民間大量栽植，困難尙多。至1954年臺灣省農業試驗所商請農林廳策劃，並承中國農村復興聯合委員會出資補助，將洋葱栽培試驗之重心工作移至中南部，同時開始多品種引進試驗，經數年來之努力，方奠定臺灣洋葱栽培之基礎。近年來漸向南移，恒春、屛東、高雄近海地帶之鹽分地，利用冬季乾燥氣候，爲洋葱生產之中心，中南部以北地區，反成爲歷史上之遺跡，玆將各品種之引進經過及其特性，分述如下，供衆參考。

本試驗農林廳爲主辦機關，農業試驗所負責設計協助辦理，並整理資材及彙編報告，全省七個區農業改良場，鳳山熱帶園藝試驗分所，種苗繁殖場，爲實際負責執行試驗工作，各試驗單位，數年來均能切實負責執行，深堪嘉佩，附此數語，以誌謝意。

二、各品種引進之經過概述

第一年 1954 年引進試作品種僅爲 (1) Early Grano (2) Excel Bermuda (3) Laredo-690 (4) Red Torbeda 四個品種，結果以前二品種適應性爲最大，產量亦最多。

第二年 1955 年除上述四品種外，再加入新品種十五個如下：

(1) Granex (2) San Joaquin (3) Texas Grano (4) White Babosa (5) White Creole (6) Crystal White Wax (7) Red Creole (8) White Portugal (9) Calif. Early Red (10) Red Bermuda (11) Stockton Yellow Globe (12) White Grano (13) India Red Globe (14) Granex Hybrid (15) Yellow Sweet Spanish. 所得結果，以 (1) Early Grano (2) Excel Bermuda (3) San Joaquin (4) Granex 爲最適應，產量亦最多；其次爲 (1) Red Creole (2) White Creole 其他各品種多不甚適應。

第三年 1956 年除上述品種外，又加入新品種十四個如下：

(1) Early Yellow Globe (2) Excel (3) Yellow Globe Danvere (4) Texas Grano 502 (5) Crystal Wax Bermuda (6) Australian Brown (7) South Part Yellow Globe (8) Granex Hybrid (9) Lowseanna Red Creole (10) Ebezer Yellow Globe (11) Burpee Yellow Globe Hybrid (12) White Babosa (13) Downings Yellow Globe (14) Brigham Yellow Globe. 經試作結果，因各年前期九月底以前播種者，連續遭颱風爲害，而少結果；後期各場所之試作成績，仍認第二年選出之品種爲最適應，是年引種之品種多屬晚生。除 (1) Early Yellow Globe (2) Texas Grano 502 外，多因臺灣之高溫而不適，鱗球發育膨軟，無經濟價值，概行淘汰。

三、各品種生育之特性調查

綜合以上三年引進品種數共達三十三個，除極晚生品種十一個，根本不適合臺灣氣候生育淘汰外，尚存二十二個品種，研究其播種期之早晚與結球率，分球率，抽苔率和產量之關係，分述如下。

1. 播種期之早晚與結球率之關係

播種期早晚，就二十二個品種一般而論，早播者其結球率均大於晚播；就品種間之差異，(1) White Creole (2) Red Creole (3) Early Grano (4) Excel Bermuda (5) San Joaquin. 五個品種，雖延至十一月中旬播種，其結球率仍可達80%以上，各播種期之平均結球率在90%以上者有六品種，結球率在80%以上，90%以下者有三品種，結球率在70%以上，80%以下者有四品種，不滿70%者有九品種，詳見下表：

表一 播種期早晚與結球率之關係 (%)

Table 1. Relation between the ratio of bulbing and the sowing time

品種 Varieties	期別及播種期 Date of sowing / 平均單位 Unite of Average	1 8.1 Aug. 1	2 8.16 Aug. 16	3 9.1 Sep. 1	4 9.16 Sep. 16	5 10.1 Oct. 1	6 10.16 Oct. 16	7 11.1 Nov. 1	8 11.16 Nov. 16	9 12.1 Dec. 1	10 12.16 Dec. 16	平均 Ave-rage
1. Granex	八場所二年平均 Ave. of 2 years and 8 Stations	99.80	100	100	95.45	98.10	96.35	100	—	—	—	98.53
2. Early Grano	九場所三年平均 Ave. of 3 years and 9 Stations	97.87	99.05	98.18	94.00	95.33	94.51	92.21	94.14	79.05	73.48	91.78
3. Red Bermuda	四場所二年平均 Ave. of 2 years and 4 Stations	63.40	78.50	—	74.15	77.22	83.92	74.33	—	—	—	75.25
4. Excel Bermuda	九場所三年平均 Ave. of 3 years and 9 Stations	93.33	97.30	90.29	95.58	92.46	94.28	95.20	92.35	82.25	70.00	90.80
5. San Joaquin	九場所二年平均 Ave. of 2 years and 9 Stations	96.67	89.40	86.70	89.04	89.10	95.93	94.46	86.25	70.47	42.67	84.07
6. Crystal White Wax	七場所二年平均 Ave. of 2 years and 7 Stations	89.40	100	77.23	89.33	88.30	85.00	84.45	72.56	40.85	28.30	75.74
7. White Grano	四場所二年平均 Ave. of 2 years and 4 Stations	66.60	40.46	—	100	86.60	67.70	57.37	40.20	—	—	65.56
8. White Creole	八場所二年平均 Ave. of 2 years and 8 Stations	—	—	—	94.94	94.37	93.63	96.67	94.47	100	93.25	95.33
9. Cailf. Early Red	三場所一年平均 Ave. of 1 year and 3 Stations	92.10	—	100	78.50	20.80	58.20	5.20	—	—	—	59.13
10. Red Creole	八場所二年平均 Ave. of 2 years and 8 Stations	—	—	—	93.00	88.56	90.10	91.57	87.09	87.98	85.40	89.10
11. Stockton G-36	二場所一年平均 Ave. of 1 year and 2 Stations	—	—	—	—	—	—	42.75	—	—	—	42.75
12. Laredo 690	五場所三年平均 Ave. of 3 years and 5 Stations	96.50	—	—	88.80	85.72	81.40	76.45	—	—	—	85.77
13. India Red Globe	三場所二年平均 Ave. of 2 years and 3 Stations	—	—	—	99.10	95.75	88.45	71.33	69.30	43.66	64.10	75.96
14. Yellow Sweet Spanish	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	35.50	55.93	49.15	49.10	18.65	27.40	19.90	—	36.52

15. White Portugal	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	39.95	55.55	95.80	78.60	13.30	53.65	14.20	—	50.15
16. Early Yellow Globe	二場所一年平均 Ave. of 1 year and 2 Stations	—	—	—	—	—	91.00	65.00	70.00	65.00	50.00	68.20
17. Texas Grano 502	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	98.47	—	—	—	100	—	—	—	99.24
18. Stockton Yellow Globe	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	71.70	97.70	21.00	40.87	47.65	70.70	—	—	58.27
19. White Babosa	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	52.13	75.30	32.10	—	—	—	—	—	53.18
20. Granex Hybrid	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	—	94.00	87.67	92.76	92.15	—	—	—	91.62
21. Ebezer Yellow Globe	一場所一年平均 Ave. of 1 year and 1 Station	—	—	14.90	94.10	61.60	75.80	15.00	56.00	—	—	52.90
22. Red Torbeda	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	—	79.25	69.00	76.12	80.37	—	—	—	76.19

2. 播種期早晚與分球率之關係

分球率均因播種期之提早而相對增加，各品種在十一月初旬以後播種者，分球率漸見減低，僅(1) Red Creole (2) White creole (3) India Red Globe 三品種，延至十二月中旬播種，尙有分球出現，各播種期之平均，分球率大於30%以上者有三品種，大於20%以上，30%以下者有四品種，大於10%以上，20%以下者有七品種，不滿10%者有八品種，詳見下表：

表二　播種期早晚與分球率之關係 (%)

Table 2. Relation between the ratio of bulb separation and the sowing time

品種 Varieties	期別及播種期 Date of sowing / 平均單位 Unite of Average	1	2	3	4	5	6	7	8	9	10	平均 Average
		8.1 Aug. 1	8.16 Aug. 16	9.1 Sep. 1	9.16 Sep. 16	10.1 Oct. 1	10.16 Oct. 16	11.1 Nov. 1	11.16 Nov. 16	12.1 Dec. 1	12.16 Dec. 16	
1. Granex	八場所二年平均 Ave. of 2 years and 8 Stations	9.60	7.70	12.25	7.10	3.60	3.40	1.30	—	—	—	6.42
2. Early Grano	九場所三年平均 Ave. of 3 years and 9 Stations	20.40	10.65	25.90	16.57	16.34	10.62	5.20	1.90	0.25	0	10.98
3. Red Bermuda	四場所二年平均 Ave. of 2 years and 4 Stations	48.35	45.40	—	70.20	44.10	36.29	35.63	—	—	—	46.66
4. Excel Bermuda	九場所三年平均 Ave. of 3 years and 9 Stations	25.31	22.20	23.21	22.08	13.08	10.21	4.03	0.91	0	0	12.10
5. San Joaquin	九場所二年平均 Ave. of 2 years and 9 Stations	30.83	5.46	9.83	5.76	7.17	3.20	1.28	0.30	0	0	6.38
6. Crystal White Wax	七場所二年平均 Ave. of 2 years and 7 Stations	75.40	81.00	63.28	54.75	47.60	43.30	10.20	7.84	0	0	38.34
7. White Grano	四場所二年平均 Ave. of 2 years and 4 Stations	18.50	10.00	—	5.90	0	0.67	0.67	0	—	—	5.15
8. White Creole	八場所二年平均 Ave. of 2 years and 8 Stations	—	—	—	39.42	31.26	30.36	24.00	8.24	4.10	1.20	19.80
9. Calif. Early Red	三場所一年平均 Ave. of 1 year and 3 Stations	7.70	—	66.60	27.20	4.00	6.85	0	—	—	—	18.73

10. Red Creole	八場所二年平均 Ave. of 2 years and 8 Stations	—	—	—	31.53	20.05	23.88	15.13	11.31	10.63	6.20	17.00
11. Stockton G-36	二場所一年平均 Ave. of 1 year and 2 Stations	—	—	—	—	—	—	0.45	—	—	—	0.45
12. Laredo 690	五場所三年平均 Ave. of 3 years and 5 Stations	49.50	—	—	35.90	23.82	18.68	12.67	—	—	—	28.11
13. India Red Globe	三場所二年平均 Ave. of 2 years and 3 Stations	—	—	—	84.60	36.85	29.50	29.60	4.76	19.05	16.70	31.58
14. Yellow Sweet Spanish	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	0	0	32.75	0	0	0	0	—	4.68
15. White Portugal	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	27.10	28.50	15.90	17.75	0	0	0	—	12.75
16. Early Yellow Globe	二場所一年平均 Ave. of 1 year and 2 Stations	—	—	—	—	—	0	0	0	0	0	0
17. Texas Grano 502	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	35.87	—	—	—	13.30	—	—	—	24.59
18. Stockton Yellow Globe	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	71.40	33.30	8.00	13.80	0	2.80	—	—	21.55
19. White Babosa	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	23.66	42.70	3.40	—	—	—	—	—	23.25
20. Granex Hybrid	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	—	1.17	1.80	2.43	0	—	—	—	1.35
21. Ebezer Yellow Globe	一場所一年平均 Ave. of 1 year and 1 Station	—	—	0	34.10	16.60	4.90	0	0	—	—	0.93
22. Red Torbeda	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	—	33.87	19.62	16.65	6.00	—	—	—	19.04

3. 播種期早晚與抽苔率之關係

抽苔率亦因播種期提早而相對增加，各品種在十一月初旬以後播種者，抽苔率則極低，僅 (1) Red Creole (2) India Red Globe 二品種，延至十二月初旬播種尚有抽苔率出現；各播種期之平均，抽苔率大於10%以上者有四品種，大於 5 %以上，10%以下者有三品種，5 %以下者有九品種，0 %者有六品種，詳見下表：

表三 播種期早晚與抽苔率之關係 (%)

Table 3. Relation between the ratio of bolting and the sowing time

品種 Varieties	期別及播種期 Date of sowing / 平均單位 Unite of Average	1	2	3	4	5	6	7	8	9	10	平均 Ave-rage
		8.1 Aug. 1	8.16 Aug. 16	9.1 Sep. 1	9.16 Sep. 16	10.1 Oct. 1	10.11 Oct. 16	1.11 Nov. 1	11.16 Nov. 16	12.1 Dec. 1	12.16 Dec. 16	
1. Granex	八場所二年平均 Ave. of 2 years and 8 Stations	2.10	0	8.18	1.44	2.94	1.47	0	—	—	—	2.30
2. Early Grano	九場所三年平均 Ave. of 3 years and 9 Stations	1.85	0	5.55	3.52	0.33	0	0	0	0	0	1.13
3. Red Bermuda	四場所二年平均 Ave. of 2 years and 4 Stations	53.05	45.40	—	34.35	16.55	30.07	0	—	—	—	29.90
4. Excel Bermuda	九場所三年平均 Ave. of 3 years and 9 Stations	0	0.55	25.50	20.55	9.09	2.65	0	0	0	0	5.83
5. San Joaquin	九場所二年平均 Ave. of 2 years and 9 Stations	0	0	0.99	0.91	0.17	0	0	0	0	0	0.21

6.	Crystal White Wax	七場所二年平均 Ave. of 2 years and 7 Stations	68.40	27.20	25.78	18.58	9.56	2.90	0.25	0	0	0	15.28
7.	White Grano	四場所二年平均 Ave. of 2 years and 4 Stations	25.90	4.70	—	0	0	0.60	0	0	—	—	4.46
8.	White Creole	八場所二年平均 Ave. of 2 years and 8 Stations	—	—	—	20.62	12.05	7.64	1.10	0	0	0	5.92
9.	Calif. Early Red	三場所一年平均 Ave. of 1 year and 3 Stations	2.60	—	0	0	0	0	0	—	—	—	0.43
10.	Red Creole	八場所二年平均 Ave. of 2 years and 8 Stations	—	—	—	41.03	38.59	26.35	8.59	10.33	1.78	0	18.10
11.	Stockton G-36	二場所一年平均 Ave. of 1 year and 2 Stations	—	—	—	—	—	—	0	—	—	—	0
12.	Laredo 690	五場所三年平均 Ave. of 3 years and 5 Stations	16.00	—	—	5.80	1.80	0.34	0	—	—	—	4.79
13.	India Red Globe	三場所二年平均 Ave. of 2 years and 3 Stations	—	—	—	94.10	44.60	63.20	63.06	21.46	16.55	1.75	43.53
14.	Yellow Sweet Spanish	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	2.90	3.66	0	0	0	0	0	—	0.94
15.	White Portugal	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	0	0	0	0	0	0	0	—	0
16.	Early Yellow Globe	二場所一年平均 Ave. of 1 year and 2 Stations	—	—	—	—	—	0	0	0	0	0	0
17.	Texas Garno 502	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	0.60	—	—	—	0	—	—	—	0.30
18.	Stockton Yellow Globe	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	0	0	0	0	0	0	—	—	0
19.	White Babosa	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	3.37	22.70	0	—	—	—	—	—	8.69
20.	Granex Hybrid	四場所一年平均 Ave. of 1 year and 4 stations	—	—	—	0	0	0	0	—	—	—	0
21.	Ebezer Yellow Globe	一場所一年平均 Ave. of 1 year and 1 Station	—	—	0	0	0	0	0	0	—	—	0
22.	Red Torbeda	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	—	0.13	1.32	0.13	0.25	—	—	—	0.46

4. 播種期早晚與產量之關係

產量因播種期提早，各品種均直線上昇，尤以早熟品種，其上昇之數字，較晚熟品種更爲明顯，各品種其播種期過份延遲，至十二月初旬以後播種者，其產量僅及早播者二分之一，或三分之一，或四分之一不等，各播種期之產量平均，每10公畝產量超過3000公斤以上者，有三品種，2000公斤以上，3000公斤以下者有四品種，1000公斤以上，2000公斤以下者有十一品種，不滿1000公斤者有四品種，詳見下表四：

四、各優良品種球型特徵之比較

就上二十二個品種中，各場所連續數年品種比較試驗結果，合於臺灣氣候，結球率高而產量多，分球率少而抽苔率低，共選出六個品種，其球型之特徵，測定如下表五：

表四 播種期早晚與產量之關係
Table 4. Relation between the yield and the sowing time

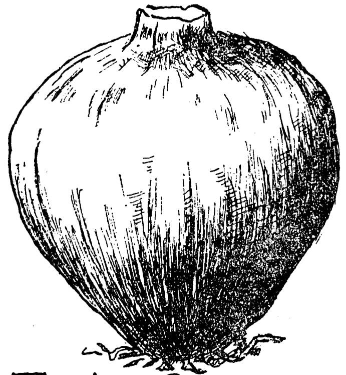
(公斤/10公畝)

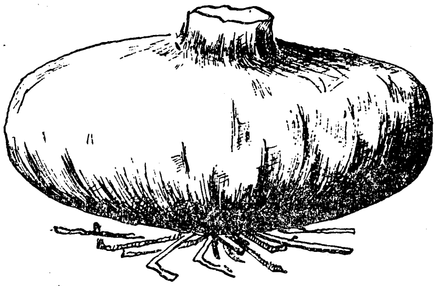
品種 Varieties	平均單位 Unite of Average \ 期別及播種期 Date of sowing	1 8.1 Aug. 1	2 8.16 Aug. 16	3 9.1 Sep. 1	4 9.16 Sep. 16	5 10.1 Oct. 1	6 10.16 Oct. 16	7 11.1 Nov. 1	8 11.16 Nov. 16	9 12.1 Dec. 1	10 12.16 Dec. 16	平均 Average
1. Granex	八場所二年平均 Ave. of 2 years and 8 Stations	4,361.86	4,104.00	3,311.00	3,802.39	3,935.50	3,302.88	3,148.00	—	—	—	3,709.38
2. Early Grano	九場所三年平均 Ave. of 3 years and 9 Stations	4,719.72	5,955.00	4,382.00	3,671.45	3,488.93	3,287.55	2,929.09	1,631.14	1,166.50	1,024.00	3,225.54
3. Red Bermuda	四場所二年平均 Ave. of 2 years and 4 Stations	1,472.10	2,804.00	—	2,436.00	2,979.66	2,956.60	1,560.31	—	—	—	2,374.78
4. Excel Bermuda	九場所三年平均 Ave. of 3 years and 9 Stations	4,442.00	4,945.50	3,908.63	3,368.32	3,242.66	3,073.90	2,505.84	1,509.67	1,272.31	807.66	2,907.65
5. San Joaquin	九場所二年平均 Ave. of 2 years and 9 Stations	3,822.31	3,623.00	2,488.40	3,008.30	3,143.36	2,956.84	2,331.99	888.49	505.50	202.00	2,297.02
6. Crystal White Wax	七場所二年平均 Ave. of 2 years and 7 Stations	3,033.00	3,944.00	2,277.00	2,171.00	1,426.00	1,424.60	1,501.00	930.21	168.62	77.00	1,695.24
7. White Grano	四場所二年平均 Ave. of 2 years and 4 Stations	3,000.00	1,500.00	—	1,657.00	1,072.00	1,320.00	1,339.00	628.00	—	—	1,502.29
8. White Creole	八場所二年平均 Ave. of 2 years and 8 Stations	—	—	—	1,897.80	1,746.33	1,680.18	1,276.33	700.00	655.00	590.00	1,220.81
9. Calif. Early Red	三場所一年平均 Ave. of 1 year and 3 Stations	2,038.90	—	549.00	461.00	724.00	1,595.50	56.00	—	—	—	904.07
10. Red Creole	八場所二年平均 Ave. of 2 years and 8 Stations	—	—	—	2,004.00	1,330.40	1,568.20	1,305.50	1,297.71	1,161.33	759.40	346.65
11. Stockton G-36	二場所一年平均 Ave. of 1 year and 2 Stations	—	—	—	—	—	—	837.50	—	—	—	837.50
12. Laredo 690	五場所三年平均 Ave. of 3 years and 5 Stations	2,683.50	—	—	1,656.75	1,435.60	1,443.40	1,001.00	—	—	—	1,644.05
13. India Red Globe	三場所二年平均 Ave. of 2 years and 3 Stations	—	—	—	1,945.00	1,576.50	1,201.00	875.00	800.62	915.50	662.00	1,142.23
14. Yellow Sweet Spanish	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	1,694.50	1,705.60	1,021.00	569.50	1,948.00	245.00	547.00	—	1,104.37
15. White Portugal	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	249.00	210.00	280.00	799.00	230.00	454.50	275.00	—	356.79
16. Early Yellow Globe	二場所一年平均 Ave. of 1 year and 2 Stations	—	—	—	—	—	1,477.00	1,315.00	1,110.00	1,221.00	94.00	1,043.40
17. Texas Grano 502	三場所一年平均 Ave. of 1 year and 3 Stations	—	—	3,014.00	—	—	—	4,704.00	—	—	—	3,859.00
18. Stockton Yellow Globe	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	1,839.00	2,200.00	778.00	1,341.33	857.50	2,053.00	—	—	1,511.47
19. White Babosa	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	1,531.00	1,444.50	1,302.00	—	—	—	—	—	1,425.83
20. Granex Hybrid	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	—	1,816.33	3,098.31	2,341.62	1,402.50	—	—	—	2,164.69
21. Ebezer Yellow Globe	一場所一年平均 Ave. of 1 year and 1 Station	—	—	116.00	224.00	135.00	497.00	265.00	639.00	—	—	312.66
22. Red Torbeda	四場所一年平均 Ave. of 1 year and 4 Stations	—	—	—	1,666.00	1,157.50	1,021.00	1,319.25	—	—	—	1,290.94

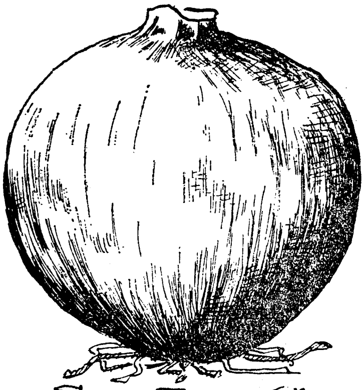
表五 優良洋葱品種球型之特徵

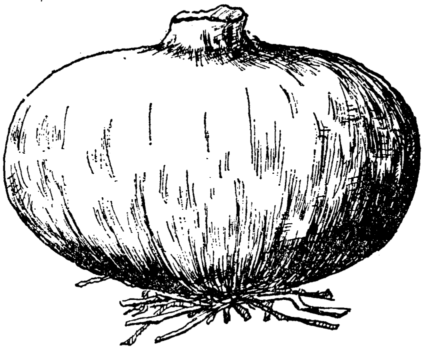
Table 5. Character of the bulbs of the better onion varieties

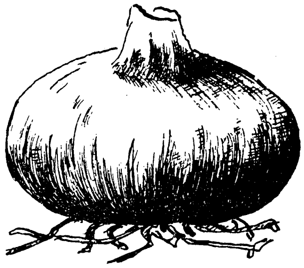
品種 Varieties	球型 Form of bulbs	外皮色澤 Color of tunic	球徑 Diameter of bulbs (cm)	球高 Height of bulbs (cm)	鱗球重量 Weight of bulbs (g)	緊密程度 Fast or loose
Early Grano	倒卵型 Obovate	淡黃 Light yellow	6.02	6.11	115.0	鬆 Loose
Excel Bermuda	扁圓型 Flat Orbicular	淡黃 Light yellow	6.51	3.96	106.3	緊 Fast
San Joaquin	近球型 Orbicular	淡黃 Light yellow	6.11	6.23	124.0	緊 Fast
Granex	扁圓型 Flat Orbicular	淡黃 Light yellow	6.59	4.52	115.0	緊 Fast
Red Creole	扁圓型 Flat Orbicular	紫紅 Violet red	4.97	3.65	53.7	緊密 Faster
White Creole	扁圓型 Flat Orbicular	白色 White	4.63	3.51	54.8	緊密 Faster

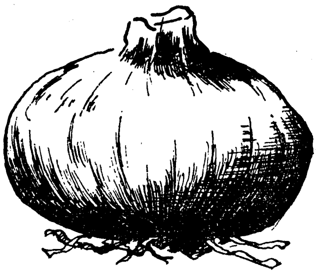

Early Grano


Excel Bermuda


San Joaquin


Granex





五、結　　　論

1. 二十二個品種，播種期提早，產量及結球率固可提高，但分球率及抽苔率亦相對增多，對洋葱品質影響甚大；過遲播種者，雖分球率及抽苔率降低，但葱球不大，產量減少，亦屬不適。

2. 早熟品種之播種適期，以九月下旬至十月中旬之間爲最佳，九月中旬以前播種，不特育苗時間常遇颱風豪雨之害，除用特殊設備覆蓋外，不易育成。晚熟品種，如 Red Creole, White Creole 等之播種適期，在南部以十月下旬爲最適，臺中以北爲十月中旬。過早播種，分球抽苔率極高，鱗球形質劣變。

3. 二十二個品種，就播種期之早晚，與產量、結球率、分球率、抽苔率之比較，合於臺灣氣候之栽培價值者早熟種有四個品種。(1) Granex (2) Early Grano (3) San Joaquin (4) Excel Bermuda，晚熟種有二個品種 (1) Red Creole (2) White Creole.

4. 晚熟種 Red Creole 及 White Creole，在生育期中，抗病力强，收穫之鱗球大小，雖不十分整齊，產量又低，但極耐貯藏，在臺灣之自然室溫下，經過炎熱漫長之暑期，腐敗率極低，爲前述早熟種所不及。

5. 此外比較試驗品種中 (1) Red Bermuda (2) White Grano (3) Crystal White Wax (4) Granex Hybrid (5) Texas Grano (6) Laredo 690 等六品種，尙有試驗調查價值外，其餘各品種，成績極差，在臺灣無栽培經濟價值。

A REPORT ON COMPARATIVE TEST OF ONION VARIETIES

by

T. H. Yu, C. S. Wang & P. N. Lee

SUMMARY

1. In a trial of twenty two onion varieties, it was found that, when the dates of planting were early in the season, the rates of bulbing and the yields were increased with higher yields of doubles and bolters. However, if the date of planting was too late in the season, the size of bulbs was so reduced that the yield was apparently decreased, although the rates of doulbling and bolting were also lowered.

2. The optimum dates of planting early harvesting varieties of onion were found between the last of September and the middle of October. Planting seeds before middle of September was dangerous because of possiblility of Typhoone damage, unless there is proper protection provided to seedbeds. The optimum dates of planting late harvesting varieties of onion, such as Red Creole, White Creole, were near the last of October in the southern part of the island, and in the middle of October in the northern part of the island.

3. Among the twenty two onion varieties tested, based upon the performance in relation to time of planting, yield, rate of bulbing and bolting habit, the following varieties were adapted to Taiwan climatic conditions:

Early harvesting varieties: Granex, Early Grano, San Joaquin, Excel Bermuda.

Late harvesting varieties: Red Creole, White Creole.

4. Red Creole and White Creole were resistant to diseases, yet low yielding with small bulbs not uniform in shape. However, these varieties were excelent keepers and could be stored over summer with very low rates of losses. The other varieties tested were all poor keepers.

5. Among the varieties tested, the following were partially adepted to Taiwan conditions, and may receive further attention: 1) Red Bermuda, 2) White Grano, 3) Crystal White Wax, 4) Granex Hybrid, 5) Texas Grano 502, 6) Laredo 690.

The varieties which did not show promising in the trial were as follows: 1) California Early Red, 2) Stockton G-36, 3) India Red Globe, 4) Yellow Sweet Spanish, 5) White Portugal, 6) Early Yellow Globe, 7) Stockton Yellow Globe, 8) White Babosa, 9) Ebezer Yellow Globe, 10) Red Torbeda.

氮磷化成肥料對水稻之效應試驗

吳啓東　溫西濱　林國謙

一、前　　言

氮磷化成肥料含磷酐14%氮16%，氮中有銨態與硝酸態兩者各半，據過去試驗成績稻田施用硝態氮時以作追肥爲宜，因此乃於民國46～48年間在臺北、桃園、埔心、員林等四處舉辦田間試驗以求明瞭其效應與適當使用法，茲將試驗結果報告於後。

二、試驗方法

試驗處理中氮肥之追肥施用時期第一期作在插秧後第20、40、60天，第二期作在插秧後第15、30、50天。使用硫酸銨與氮磷化成肥料區，各分別在插秧前全部用於基肥之處理和無氮處理共12區採用隨機區組排列四次重覆共48小區每小區面積爲 0.1公畝 (2.5m×4.0m) 除員林一地自民國46年第二期作開始試驗即遲辦一期作外余均舉行田間試驗 6 期作。

試驗處理：(第一期作)

(1)	M^{0}_{1}	(2)	$M^{0}_{1/2}$ $M^{20}_{1/2}$	(3)	$M^{0}_{1/2}$ $M^{40}_{1/2}$	(4)	$M^{0}_{1/2}$ $M^{60}_{1/2}$
(5)	A^{0}_{1}	(6)	$A^{0}_{1/2}$ $A^{20}_{1/2}$	(7)	$A^{0}_{1/2}$ $A^{40}_{1/2}$	(8)	$A^{0}_{1/2}$ $A^{60}_{1/2}$
(9)	0	(10)	$A^{0}_{1/2}$ $M^{20}_{1/2}$	(11)	$A^{0}_{1/2}$ $M^{40}_{1/2}$	(12)	$A^{0}_{1/2}$ $M^{60}_{1/2}$

(第二期作)

(1)	M^{0}_{1}	(2)	$M^{0}_{1/2}$ $M^{15}_{1/2}$	(3)	$M^{0}_{1/2}$ $M^{30}_{1/2}$	(4)	$M^{0}_{1/2}$ $M^{50}_{1/2}$
(5)	A^{0}_{1}	(6)	$A^{0}_{1/2}$ $A^{15}_{1/2}$	(7)	$A^{0}_{1/2}$ $A^{30}_{1/2}$	(8)	$A^{0}_{1/2}$ $A^{50}_{1/2}$
(9)	0	(10)	$A^{0}_{1/2}$ $M^{15}_{1/2}$	(11)	$A^{0}_{1/2}$ $M^{30}_{1/2}$	(12)	$A^{0}_{1/2}$ $M^{50}_{1/2}$

M 卽表示氮磷化成肥料　　A 表示硫酸錏

代號處理 0 表示不施氮肥區，字母右上方數字示施肥時間(指插秧後日數)字母之右下方數字示氮肥施用量，(以佔總量之比率)氮施用量均爲每期作每公頃80公斤計算，磷之施用量以氮磷化成肥料中之磷量爲標準，硫酸錏區之磷則全部施用過磷酸鈣。鉀用硫酸鉀或氯化鉀每試驗小區之施用量亦以80公斤/公頃折算。

三、試驗結果與檢討

氮磷化成肥料與硫酸錏對於水稻肥效之比較。

由各處理間谷實收量比較表(表一)觀之，氮磷化成肥料區之谷實收量，在水稻生育晚期施用追肥區大多高於其他處理區。併且亦有達到差異顯著平準，但硫酸錏肥料使用區在第一期作卽甚少見此現象，換言之化成肥料在水稻生育末期施用時之效用較高於生育初期施用爲追肥時之效果，在使用硫酸錏肥料爲稻田肥料時併未發現此種趨勢，但化成肥料之追肥施用適期問題倘待更詳細之研討。各地試驗區處理中硫酸錏全量以基肥使用之處理小區收量指數爲 100，計算使用化成肥料與硫酸錏兩者各分別爲基肥與追肥使用區爲比較對象，谷實及藁稈之收量指數如表二、三。

本試驗經費承中國農村復興聯合委員會補助，試驗進行中承省立桃園農校，省立員林農校，及平鎮茶業試驗分所鼎力協助作者等謹此誌謝！

表一、氮磷化成肥料與硫酸錏肥料使用時對谷實收量影響之比較

谷實收量（公斤/公頃）

期作	地點	年別	M^0_1	$M^0_{1/2}\ M^{20}_{1/2}$	$M^0_{1/2}\ M^{40}_{1/2}$	$M^0_{1/2}\ M^{60}_{1/2}$	A^0_1	$A^0_{1/2}\ A^{20}_{1/2}$	$A^0_{1/2}\ A^{40}_{1/2}$	$A^0_{1/2}\ A^{60}_{1/2}$	L. S. D. 5%	1%
第一期作	臺北	46	3,083	3,093	3,530	3,215	3,370	3,788	3,758	3,435	349	451
		47	4,344	4,506	4,417	4,970*	4,742	5,095	4,865	4,610*	582	784
		48	2,850	2,737	3,092	2,837	2,942	2,930	3,075	3,162*	361	487
	桃園	46	4,069	4,620	4,996	4,642	4,331	5,058	5,138	4,130	698	941
		47	4,160	3,840	4,500	4,508*	4,665	4,768	4,860	4,773	391	526
		48	3,678	3,288	3,485	3,783*	4,013	3,800	4,130	3,950	108	145
	埔心	46	5,050	4,775	5,125	4,625	4,925	4,950	4,825	4,650	498	670
		47	2,675	3,087	3,162	3,500*	3,250	3,875	3,612	3,250	323	438
		48	3,775	3,738	4,100	3,825	3,863	4,063	3,713	4,100*	319	429
	員林	46	—	—	—	—	—	—	—	—	—	
		47	2,369	2,429	2,544	2,350	3,151	3,256	3,375	2,705	223	300
		48	2,043	2,498	2,695	2,583	3,150	3,200	3,153	2,853	265	357

期作	地點	年別	M^0_1	$M^0_{1/2}\ M^{15}_{1/2}$	$M^0_{1/2}\ M^{30}_{1/2}$	$M^0_{1/2}\ M^{50}_{1/2}$	A^0_1	$A^0_{1/2}\ A^{15}_{1/2}$	$A^0_{1/2}\ A^{30}_{1/2}$	$A^0_{1/2}\ A^{50}_{1/2}$	L. S. D. 5%	1%
第二期作	臺北	46	3,095	3,196	3,229	3,243*	3,470	3,295	3,254	3,411	445	600
		47	3,998	3,730	4,120	4,033	3,725	3,698	3,900	3,413	117	151
		48	2,490	2,364	2,613	2,680*	2,405	2,380	2,591	2,870*	216	352
	桃園	46	2,463	3,768	3,197	2,993	3,250	3,748	4,540	3,110	459	619
		47	4,030	3,890	4,195	3,973	4,190	3,360	4,210	3,970	259	349
		48	3,815	3,643	3,720	3,817*	3,817	3,617	3,660	3,877*	404	545
	埔心	46	4,025	4,000	4,100	4,175*	4,225	4,350	4,475	4,700*	552	718
		47	2,925	2,650	2,650	2,450	3,225	3,200	3,175	3,325*	641	863
		48	3,575	3,750	4,000	3,800	3,725	3,650	3,925	3,675	353	476
	員林	46	2,189	2,240	2,318	2,400*	2,763	2,625	2,740	2,900*	247	332
		47	2,718	2,788	2,593	2,953*	3,473	3,648	3,628	3,515	390	525
		48	1,458	1,405	1,368	1,468*	2,023	1,810	1,900	2,125*	208	281

附有『*』記號者表示晚期施用追肥時對谷實之生產成績較優。

表二、三年平均谷實收量指數

（A^0_1 區收量爲 100 計算）

期作	地址	M^0_1	$M^0_{1/2}\ M^{20}_{1/2}$	$M^0_{1/2}\ M^{40}_{1/2}$	$M^0_{1/2}\ M^{60}_{1/2}$	$A^0_{1/2}\ A^{20}_{1/2}$	$A^0_{1/2}\ A^{40}_{1/2}$	$A^0_{1/2}\ A^{60}_{1/2}$
第一期作	臺北	93.0	93.5	99.9	99.7	106.9	105.8	101.4
	桃園	91.5	90.3	99.8	99.4	104.8	108.6	98.8
	埔心	95.5	96.3	102.9	99.3	107.1	100.9	99.7
	員林	70.0	78.2	83.1	78.3	102.4	103.6	88.2

期作	地址	M^0_1	$M^0_{1/2}\ M^{15}_{1/2}$	$M^0_{1/2}\ M^{30}_{1/2}$	$M^0_{1/2}\ M^{50}_{1/2}$	$A^0_{1/2}\ A^{15}_{1/2}$	$A^0_{1/2}\ A^{30}_{1/2}$	$A^0_{1/2}\ A^{50}_{1/2}$
第二期作	臺北	99.8	96.8	103.8	103.5	97.6	101.3	101.0
	桃園	91.6	100.4	98.7	95.8	95.3	110.3	97.3
	埔心	94.2	93.1	96.2	93.3	100.2	103.6	104.7
	員林	77.1	77.9	76.0	82.6	97.9	100.0	103.4

表三、三年平均藁稈收量指數

期作	地址	M^0_1	$M^0_{1/2}\ M^{20}_{1/2}$	$M^0_{1/2}\ M^{40}_{1/2}$	$M^0_{1/2}\ M^{60}_{1/2}$	$A^0_{1/2}\ A^{20}_{1/2}$	$A^0_{1/2}\ A^{40}_{1/2}$	$A^0_{1/2}\ A^{60}_{1/2}$
第一期作	臺北	87.5	89.2	106.6	88.2	102.9	114.9	91.6
	桃園	97.6	92.8	99.8	98.7	107.8	112.3	97.0
	埔心	87.1	91.7	100.2	82.9	104.9	99.4	91.9
	員林	—	—	—	—	—	—	—

期作	地址	M^0_1	$M^0_{1/2}\ M^{15}_{1/2}$	$M^0_{1/2}\ M^{30}_{1/2}$	$M^0_{1/2}\ M^{50}_{1/2}$	$A^0_{1/2}\ A^{15}_{1/2}$	$A^0_{1/2}\ A^{30}_{1/2}$	$A^0_{1/2}\ A^{50}_{1/2}$
第二期作	臺北	91.0	88.2	97.0	86.5	101.0	99.1	89.6
	桃園	82.3	91.1	88.9	92.9	104.0	119.7	95.6
	埔心	90.9	93.3	92.8	86.7	97.7	100.5	94.7
	員林	—	—	—	—	—	—	—

由表二丶三之收量指數可知氮磷化成肥料之對水稻谷實與藁稈生產之效用確遜於硫酸錏肥料，又該肥料分爲基肥與追肥施用時雖稍有增加但其對於水稻生產之作用乃未能達到使用硫酸錏肥料時之程度。氮磷化成肥料追肥施用時期不同對水稻產量影響，即例如第一期作之插秧後第20天施追肥與第60天後之比較及第二期作之插秧後第15天與第50天施追肥之比較結果第一期作谷實收量，在四處試驗地均示晚期追肥時之產量指數高於早期追肥施用區，而硫酸錏肥料却相反。早期追肥之施用區指數高於晚期追肥施用區，第二期作之谷實收量除桃園一地外氮磷化成肥料在插秧後第50天施用追肥區之收量指數高於插秧後15天使用追肥區。

由於三年平均收量指數（表二丶三）得知硫酸錏之使用對於水稻之生產效果，高於氮磷化成肥料使用區，在谷實收量（表一）中硫酸錏區產量高於氮磷化成肥料區之程度頗難斷定，在多次試驗中仍有少數之試驗區乃呈化成肥料之效用高於硫酸錏，這高低互見之現象或因試驗地點或因年次而異，爲着進一步明瞭兩種肥料間差異之程度，由谷實藁稈收量觀之(表四)。肥料種類與谷實，藁稈兩者間未發見明顯的相關關係。從表四可看出化成肥料之使用與硫酸錏肥料比較時谷實收量方面，除民國47年第二期作在臺北丶桃園其余之產量均較爲低落。

表四、化成肥料施用區與硫酸錏施用區間收量差異顯著性之比較
（化成肥料全量爲基肥使用區與硫酸錏全量做基肥區比較而追肥施用區卽與硫酸錏使用區之每同一時期追肥施用區爲比較之對象）

期作	地點	年別	谷實 1 M^0_1	谷實 2 $M^0_{1/2}\ M^{20}_{1/2}$	谷實 3 $M^0_{1/2}\ M^{40}_{1/2}$	谷實 4 $M^0_{1/2}\ M^{60}_{1/2}$	藁稈 1 M^0_1	藁稈 2 $M^0_{1/2}\ M^{20}_{1/2}$	藁稈 3 $M^0_{1/2}\ M^{40}_{1/2}$	藁稈 4 $M^0_{1/2}\ M^{60}_{1/2}$
第一期作	臺北	46		++				++		+
		47								
		48								
	桃園	46							+	++
		47	+	++				++		++
		48	++	++	++	++			++	++
	埔心	46					++	++		+
		47	++	++	++		++	++		
		48		+	*				*	
	員林	46								
		47	++	++	++	++	++	++	++	++
		48	++	++	++	+		++	++	+

（46年第一期作在員林倘未舉辦試驗）

第二期作	臺北	46					++	++	++	
		47	**		**	**				
		48								
	桃園	46	++		++		++	++	++	
		47		**			+	++	+	
		48							++	
	埔心	46								+
		47				++	+	++	++	++
		48								
	員林	46	++	++	++	++				
		47	++	++	++	++	++	++	++	++
		48	++	++	++	++	++	++	++	++

* 化成肥料高於硫酸錏區達5%顯著平準　　+ 化成肥料低於硫酸錏區達5%顯著平準

** 化成肥料高於硫酸錏區達1%顯著平準　　++ 化成肥料低於硫酸錏區達1%顯著平準

½氮素用硫酸錏作基肥其餘用氮磷化成肥料作追肥施用。現以½之氮素用硫酸錏作基肥，其餘用氮磷化成肥料在插秧後不同時期作追肥施用，所得結果和單使用化成肥料區比較時其差異顯著性如表六。就該表第一期作谷實收量云，氮素之半量以化成肥料當追肥施用時其收量高於全部使用化成肥料區而達差異顯著平準在插秧後第20天施用區11次中佔七次。插秧後第40天和第60天施用區即11次當中各佔3次，此現象在第二期作時即較少。其詳細數字由表五之谷實收量比較表可窺見，其中差異最高者第一期作收量在桃園相差570公斤，第二期作在員林有四區亦達差異500公斤左右。

表五、硫酸錏爲基肥氮磷化成肥料使用爲追肥時之谷實收量與單使用氮磷化成肥料時之比較

谷實收量　公斤/公頃

期作	地點	年別	$A^{0}_{1/2} M^{20}_{1/2}$	$A^{0}_{1/2} M^{40}_{1/2}$	$A^{0}_{1/2} M^{60}_{1/2}$	$M^{0}_{1/2} M^{20}_{1/2}$	$M^{0}_{1/2} M^{40}_{1/2}$	$M^{0}_{1/2} M^{60}_{1/2}$	L. S. D. 5%	L. S. D. 1%
第一期作	臺北	46	3,470	3,590	3,293	3,093	3,530	3,215	349	451
		47	4,605	4,572	5,220	4,506	4,417	4,970	582	784
		48	2,875	2,937	3,325	2,737	3,092	2,837	361	487
	桃園	46	4,664	4,349	4,534	4,620	4,996	4,642	698	941
		47	4,410	4,772	4,715	3,840	4,500	4,508	391	526
		48	3,653	3,600	3,983	3,288	3,485	3,783	108	145
	埔心	46	5,025	4,750	4,875	4,775	5,125	4,625	498	670
		47	3,512	3,262	3,462	3,087	3,162	3,500	323	438
		48	4,000	4,113	4,138	3,738	4,100	3,825	319	429
	員林	46	—	—	—	—	—	—	—	
		47	2,822	3,025	2,669	2,429	2,544	2,350	223	300
		48	2,793	3,103	2,755	2,498	2,695	2,583	265	357

期作	地點	年別	$A^{0}_{1/2} M^{15}_{1/2}$	$A^{0}_{1/2} M^{30}_{1/2}$	$A^{0}_{1/2} M^{50}_{1/2}$	$M^{0}_{1/2} M^{15}_{1/2}$	$M^{0}_{1/2} M^{30}_{1/2}$	$M^{0}_{1/2} M^{50}_{1/2}$	L. S. D. 5%	L. S. D. 1%
第二期作	臺北	46	3,168	3,390	3,103	3,196	3,229	3,243	445	600
		47	3,875	3,983	4,073	3,730	4,120	4,033	117	151
		48	2,415	2,594	2,843	2,364	2,613	2,680	216	352
	桃園	46	3,043	3,340	2,955	3,768	3,197	2,993	459	619
		47	4,063	4,298	3,995	3,890	4,195	3,973	259	349
		48	3,963	3,642	3,955	3,643	3,720	3,817	404	545
	埔心	46	4,125	4,300	4,500	4,000	4,100	4,175	552	718
		47	3,225	3,225	3,375	2,650	2,650	2,450	641	863
		48	3,675	3,700	3,700	3,750	4,000	3,800	353	476
	員林	46	2,783	2,873	2,698	2,240	2,318	2,400	247	332
		47	3,155	3,058	3,235	2,788	2,593	2,953	390	525
		48	1,813	1,848	1,665	1,405	1,368	1,468	208	281

表六、化成肥料與硫酸錳配合施用區與化成肥料施用區間收量差異顯著性之比較

期作	地點	年別	谷實 $A^{0}_{1/2}\ M^{20}_{1/2}$	谷實 $A^{0}_{1/2}\ M^{40}_{1/2}$	谷實 $A^{0}_{1/2}\ M^{60}_{1/2}$	藁稈 $A^{0}_{1/2}\ M^{20}_{1/2}$	藁稈 $A^{0}_{1/2}\ M^{40}_{1/2}$	藁稈 $A^{0}_{1/2}\ M^{60}_{1/2}$
第一期作	臺北	46	*			*	* *	
		47						
		48			* *			*
	桃園	46						
		47	* *			* *		
		48	* *	*	* *			*
	埔心	46						
		47	*					
		48	*					
	員林	46	—	—	—	—	—	—
		47	* *	* *	* *	* *	* *	* *
		48	*	* *	* *		* *	*
第二期作	臺北	46				* *	*	
		47	*	+				
		48						
	桃園	46	+ +					
		47				* *	*	
		48						
	埔心	46						
		47			* *	* *	* *	* *
		48						
	員林	46	* *	* *	*			
		47		*			* *	
		48	* *	* *		* *	*	

* * 化成肥料與硫酸錳配合施用區收量高於單施化成肥料區差異達 1 %顯著平準

* 化成肥料與硫酸錳配合施用區收量高於單施化成肥料區差異達 5 %顯著平準

+ + 化成肥料與硫酸錳配合施用區收量低於單施化成肥料區差異達 1 %顯著平準

+ 化成肥料與硫酸錳配合施用區收量低於單施化成肥料區差異達 5 %顯著平準

表七、三年平均谷實收量指數 (A^{0}_{1} 區收量爲100計算)

期作	地點	$A^{0}_{1/2}\ M^{20}_{1/2}$	$A^{0}_{1/2}\ M^{40}_{1/2}$	$A^{0}_{1/2}\ M^{60}_{1/2}$	$M^{0}_{1/2}\ M^{20}_{1/2}$	$M^{0}_{1/2}\ M^{40}_{1/2}$	$M^{0}_{1/2}\ M^{60}_{1/2}$
第一期作	臺北	99.1	100.4	107.1	93.5	99.9	99.7
	桃園	97.8	97.8	101.7	90.3	99.8	99.4
	埔心	104.1	100.7	103.6	96.3	102.9	99.3
	員林	89.1	97.2	86.1	78.2	83.1	78.3

期作	地點	$A^{0}_{1/2}\ M^{15}_{1/2}$	$A^{0}_{1/2}\ M^{30}_{1/2}$	$A^{0}_{1/2}\ M^{50}_{1/2}$	$M^{0}_{1/2}\ M^{15}_{1/2}$	$M^{0}_{1/2}\ M^{30}_{1/2}$	$M^{0}_{1/2}\ M^{50}_{1/2}$
第二期作	臺北	98.5	103.8	104.4	96.8	103.8	103.5
	桃園	98.3	100.2	96.9	100.4	98.7	95.8
	埔心	99.5	100.5	103.6	93.1	96.2	93.3
	員林	93.9	94.2	92.0	77.9	76.0	82.6

表八、三年平均藁桿收量指數

期作	地點	$A^0_{1/2}$ $M^{20}_{1/2}$	$A^0_{1/2}$ $M^{40}_{1/2}$	$A^0_{1/2}$ $M^{60}_{1/2}$	$M^0_{1/2}$ $M^{20}_{1/2}$	$M^0_{1/2}$ $M^{40}_{1/2}$	$M^0_{1/2}$ $M^{60}_{1/2}$
第一期作	臺北	96.1	106.4	101.1	86.2	106.6	88.2
	桃園	102.3	98.2	99.1	92.8	99.8	98.7
	埔心	95.7	96.4	91.7	91.7	100.2	82.9
	員林	—	—	—	—	—	—

期作	地點	$A^0_{1/2}$ $M^{15}_{1/2}$	$A^0_{1/2}$ $M^{30}_{1/2}$	$A^0_{1/2}$ $M^{50}_{1/2}$	$M^0_{1/2}$ $M^{15}_{1/2}$	$M^0_{1/2}$ $M^{30}_{1/2}$	$M^0_{1/2}$ $M^{50}_{1/2}$
第二期作	臺北	97.9	98.5	90.6	88.2	97.0	86.5
	桃園	95.4	95.9	92.5	91.1	88.9	92.9
	埔心	99.2	96.7	94.0	93.3	92.8	86.7
	員林	—	—	—	—	—	—

四、結　　言

水稻栽培使用氮磷化成肥料依本次試驗結果觀之與硫酸錏之使用效果比較時稍有遜色，若要提高其對水稻生產之效果氮磷化成肥料須當追肥使用爲宜。即以硫酸錏爲基肥氮磷化成肥料爲追肥使用。

五、摘　　要

爲明瞭使用氮磷化成肥料栽培水稻時之適當使用方法在民國 46～48 年間選擇臺北、桃園、埔心、員林等地擧辦田間試驗，每試驗地均同樣設置12處理 4 重覆隨機排列法之田間設計，由本次試驗結果顯示單使用氮磷化成肥料對于水稻生產效果較使用硫酸錏爲差，若使用硫酸錏爲基肥氮磷化成肥料當追肥使用時之水稻產量較高於全部使用氮磷化成肥料。各試驗處理區谷實收量指數總平均如下。

（A^0_1 區爲指數 100）

期作	M^0_1	$M^0_{1/2}$ $M^{20}_{1/2}$	$M^0_{1/2}$ $M^{40}_{1/2}$	$M^0_{1/2}$ $M^{60}_{1/2}$	$A^0_{1/2}$ $A^{20}_{1/2}$
一期作	87.5	89.6	96.4	94.2	105.3
二期作	90.7	92.1	93.7	93.8	97.8

期作	$A^0_{1/2}$ $A^{40}_{1/2}$	$A^0_{1/2}$ $A^{60}_{1/2}$	$A^0_{1/2}$ $M^{20}_{1/2}$	$A^0_{1/2}$ $M^{40}_{1/2}$	$A^0_{1/2}$ $M^{60}_{1/2}$
一期作	104.7	97.0	97.5	99.0	99.6
二期作	103.8	101.6	97.6	99.7	99.2

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AN EXPERIMENT ON THE AVAILABILITY OF NITROPHOSPHATE FOR RICE

by

C. T. Wu, H. P. Wen and K. C. Lin

SUMMARY

Field experiments were conducted in Taipei, Taoyeun, Pushin and Yenlin in order to find the most effective method of application for the nitrophosphate.

The experimental design has 12 treatment with 4 replication arranged in randomized black. It was found in these experimental results that nitrophosphate alone gave yield less than that of ammonium sulphate. When ammonium sulphate was used as base manure and nitrophate as top-dressing, the crop yield was also higher than that of using nitrophosphate alone.

(the yield index of A^0_1 plot as 100)

1st crop	M^0_1 87.5	$M^0_{1/2}$ $M^{20}_{1/2}$ 89.6	$M^0_{1/2}$ $M^{40}_{1/2}$ 96.4	$M^0_{1/2}$ $M^{60}_{1/2}$ 94.2	$A^0_{1/2}$ $A^{20}_{1/2}$ 105.3
2nd crop	M^0_1 90.7	$M^0_{1/2}$ $M^{15}_{1/2}$ 92.1	$M^0_{1/2}$ $M^{30}_{1/2}$ 93.7	$M^0_{1/2}$ $M^{50}_{1/2}$ 93.8	$A^0_{1/2}$ $A^{15}_{1/2}$ 97.8

1st crop	$A^0_{1/2}$ $A^{40}_{1/2}$ 104.7	$A^0_{1/2}$ $A^{60}_{1/2}$ 97.0	$A^0_{1/2}$ $M^{20}_{1/2}$ 97.5	$A^0_{1/2}$ $M^{40}_{1/2}$ 99.0	A^0_{102} $M^{60}_{1/2}$ 99.6
2nd crop	$A^0_{1/2}$ $A^{30}_{1/2}$ 103.8	$A^0_{1/2}$ $A^{50}_{1/2}$ 101.6	$A^0_{1/2}$ $M^{15}_{1/2}$ 97.6	$A^0_{1/2}$ $M^{30}_{1/2}$ 99.7	$A^0_{1/2}$ $M^{50}_{1/2}$ 99.2

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